Rio Mora

Stream Inventory Report

Santa Fe National Forest

Surveyed: June 2007 to August 2007

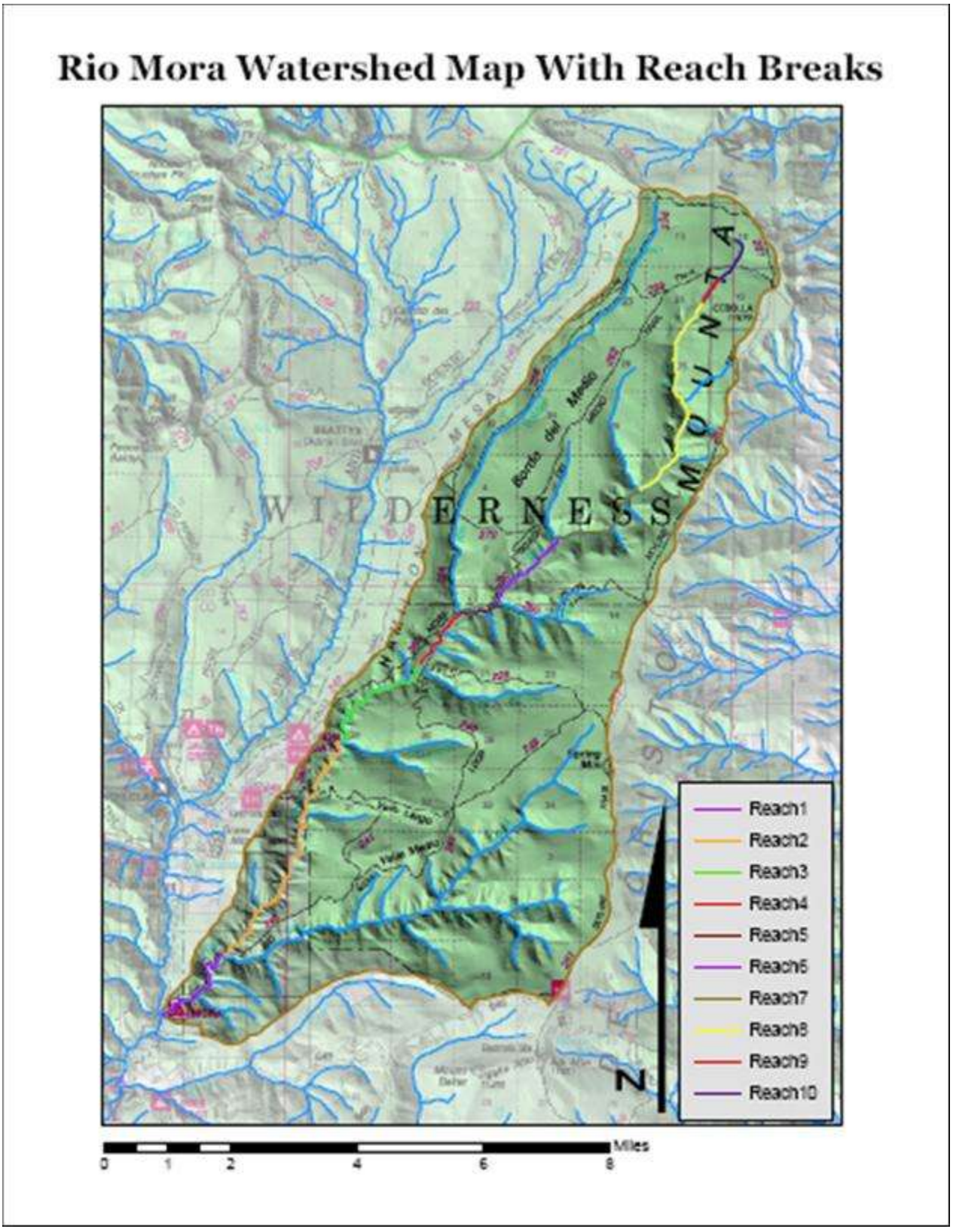
Report By
Andrew Erdmann
Hydrologic Technician

Reviewed By
Amy Unthank
Regional Fisheries Biologist

Santa Fe National Forest
February 2008

Table of Contents

RIO MORA WATERSHED MAP



Map 1 - Rio Mora Watershed Map Showing Reach Breaks

This document is a specialist report. It is meant to assist managers in understanding current conditions of a stream corridor and possibly how those conditions have developed over a period of time. Recommendations are drawn up emphasizing the aquatic resource, although the accomplishment of multiple use is considered within those recommendations.

Readers should note that there is some amount of repetition in this document. The author assumes that readers may only read certain sections; therefore, points or observations may be repeated. A glossary is provided at the end of document to help the reader think like a fish biologist. In addition, appendices provide greater detail on certain data points.

This document contains material on environmental and biological conditions in the area which is borrowed from the Upper Pecos Stream Inventory. The Upper Pecos River Inventory was written by Damon Goodman and based on surveys in an adjacent watershed conducted in 2002.

INTRODUCTION

Rio Mora 2007 Stream Survey

The headwaters of the Rio Mora are located in the Pecos Wilderness area of the Santa Fe National Forest. The beginning elevation of the stream is 11600' and the stream drops to 8000' over the 19.5 miles of its length. The Rio Mora ends at its confluence with the Pecos River, which occurs near state route 63. A heavily used campground managed by the New Mexico Department of Game and Fish is located along the river's left bank at this point.

Photo 1 – View of the Mora watershed from trail 251.

The USDA Forest Service Region 3 stream survey protocol is a modified version of the Stream Inventory Handbook used in the Pacific Northwest Region (USFS Region 6, 2001). Under this protocol, streams are surveyed from the mouth upstream and the river is separated into riffle, pool, side channel, dry channel, culvert, and falls habitat types by specific attributes (USDA FS

2002b). Different habitat types require specific measurements relevant to evaluating the habitat (Appendix A, Table 56). In addition to the habitats located in the primary stream, tributary mouths are also surveyed and approximations are made of the contribution of each tributary to the overall stream flow at that point. All habitat types are assigned a Natural Sequence Order number (NSO) in the order that they are surveyed. The stream, as a collection of NSOs, is further organized by homogeneous sections and grouped into a sequence of reaches. Each reach is assigned a number in the order that it is surveyed and analyzed separately, and a holistic overview of the system is taken by combining the data from each of these reaches.

A matrix of factors and indicators was developed to relate stream habitat information into an easily understood habitat condition classification of properly functioning, at risk, or not properly functioning (see Table 1). The matrix originally was developed in the Pacific Northwest by US Fish & Wildlife Service and National Marine Fisheries Service, and has been modified for mountain streams in the intermountain west with consideration of New Mexico Environment Department (NMED) regulations. The matrix has been further refined to incorporate geology of streams historically occupied by Rio Grande cutthroat trout (see Table 1).

Snorkel surveys are another aspect of the stream inventory incorporated for understanding fish populations. Snorkel surveys evaluate fish species presence/absence, distribution within the system, relative composition, and size class analysis in selected areas of the stream. Snorkel protocol involves surveying upstream in 100-meter transects and classifying fish that pass downstream (see Photo 2). Fish species are identified, placed into size categories and counted by the surveyor.

Photo 2 – Snorkel surveying on Reach 2 (July 2007).

Table 1 – Matrix of factors and indicators of habitat condition for historic and currently occupies Rio Grande Cutthroat Trout (RGCT) streams as related to R3 Stream Habitat Inventory.

FACTORS	INDICATORS	Properly Functioning	At Risk	Not Properly Functioning
Water Quality	***Temperature – State of New Mexico Standards***	<20°C (68°F) (3 day avg. max)	≥20°C (68°F) <23°C (73.4°F) (3 day avg. max)	≥23°C (73.4°F) (3 day avg. max)
	Temperature – Salmonid Development	≤17.8°C (64°F) (7 day avg. max)	>17.8º (64ºF) < 21.1º (70ºF) (7 day avg. max)	≥21.1ºC (70ºF) (7 day avg. max)
Habitat Characteristics	**Sediment**	<20% fines (sand, silt, clay) in riffle habitat. Fine sediment within range of expected natural streambed conditions		≥20% fines (sand, silt, clay) in riffle habitat. Fine sediment outside of expected natural streambed conditions.
	Large Woody Debris[1]	>30 pieces per mile, >12" diameter, > 35 feet (or twice \width) in length	20-30 pieces per mile, >12" diameter, > 35 feet (or twice bankfull width) in length	<20 pieces per mile, >12" diameter, > 35 feet (or twice bankfull width) in length
	Pool Development[2]	≥30% pool habitat by area[3]		<30% pool habitat by area.
	Pool Quality	Average residual pool depth ≥1 foot		Average residual pool depth <1 foot
Channel Condition and Dynamics	**Width/Depth Ratios by Channel Type** *(utilize Rosgen type*[4] *and range given if applicable)*	Width/depth ratios and channel types within natural ranges and site potential		Width/depth ratios and channel types are well outside of historic ranges and/or site potential
		Expected range of bankfull width/depth ratios and channel type	**Rosgen Type**[4] A, E, G B, C, F D	**W/D Ratio** <12 12-30 >40
	Stream Bank Condition[5]	<10% unstable banks (lineal stream bank distance)	10-20% unstable banks (lineal stream bank distance)	>20% unstable banks (lineal stream bank distance)

The primary objectives of the Region 3 stream surveys on the Santa Fe National Forest include the compilation of historical information and in-stream habitat data to assist in proper management decisions of the surveyed stream and its watershed. The historical information provides a background of land use and management actions collected from the Forest Service and a variety of other sources. The current condition of environmental systems reflect previous land use and management practices. The available historical information helps explain the current condition of the river and is incorporated into the survey. Understanding events that formed the habitat condition enhances decision-maker options. In-stream survey data is collected to provide an overview of the current condition of a stream and produce a "snapshot" in time of the stream's habitat condition and the factors affecting it (see Figure 3). Survey information can be used to identify both degraded sections as well as ideal areas to be used as a reference or model for other similar sections of stream. By combining the historical and current information pertaining to a stream, management options can be more clearly identified, which is

[1] Large Woody Debris (LWD) is not used as a category to rate habitat quality in reaches where there is no local recruitment of LWD.
[2] Pool Development is a category applicable to streams whose order is 3 or larger.
[3] Area is defined as habitat length.
[4] Rosgen Stream typing is a method of categorizing streams based on their location, flow, and morphological characteristics, and is used throughout this document to describe stream channel type, condition, and dunamics (Rosgen and Silvey, 1998).
[5] Stream Bank Condition is a category that is not applicable in reaches whose gradient exceeds 4%.

the goal of this document. This document is also consistent with goals stipulated in the Santa Fe National Forest Plan objectives for wilderness areas to, "inventory, evaluate, and improve areas of streams, lakes, and wet lands for cold water fisheries, particularly the Rio Grande Cutthroat Trout," and to "manage wildlife habitat in a manner which contributes to wilderness values."(Forest Plan, 133 & 127)

Photo 3 - Documentation a beaver dam - Reach 6, NSO 316 (July 2007)

BASIN SUMMARY

Table 2 - Basin Summary data for the Rio Mora.

Location		
	County	**San Miguel**
	Forest	**Santa Fe National Forest**
	District/s	**Pecos and Las Vegas**
	Drainage	**Rio Mora**
	Tributary to	**Pecos River**
	Survey Start Point	**Confluence of Rio Mora & Pecos River**
Watershed		
	5th HUC Code[6]	**13060000102**
	Rio Mora Watershed Area	**34,530 acres/54 square miles**
	Stream Order	**4**
	Stream Length	**19.8 miles**
Aquatic Biota		
		Rio Grande Cutthroat Trout[7] *(oncorhynchus clarki virginalis*), Rainbow Trout *(oncorhynchus* mykiss), Cut-Bow Trout[8], Brown Trout *(salmo trutta)*.

EXECUTIVE SUMMARY

The Rio Mora has its headwaters at 11,600 feet, high in the Pecos Wilderness Area of the Santa Fe National Forest in a south-west facing valley near the southern edge of the Sangre de Cristo Mountains in Northern New Mexico. The Mora River travels nearly 20 miles from its headwaters to its confluence with the Upper Pecos River. Of this distance, the upper 16 miles are located in the Wilderness Area, and there is no vehicle access beyond the lowest 0.5 miles of the stream. The stream survey assessed the entire length of this river – from the confluence to the headwaters – in order to examine channel morphology, stream characteristics, and species distribution in order to evaluate fish habitat conditions.

The Rio Mora stream survey identified 10 reaches based on stream flow, habitat, and morphological characteristics. Reach breaks were made at tributaries whose input substantially altered stream flow and when valley shape and/or channel morphology changed significantly and for a sustained distance. Reach numbers were assigned sequentially during the survey, beginning with the Rio's confluence with the Pecos (see Table 3)

The average gradient for the Rio Mora is 3.65%, or 192.7 feet of elevation per stream mile. The steepest reach is Reach 9, which has an average gradient of 7% and is composed of a series of steep rocky chutes and falls, and the shallowest is Reach 1, with an average gradient of 2.7%.

Table 3 - Reach Break descriptions and lengths.

Reach	River Miles	Start Point	End Point
1	0 to 1.9	Confluence of Rio Mora and Pecos River	Confluence of Rio Mora and Bear Creek
2	1.7 to 6.7	Confluence of Rio Mora and Bear Creek	Confluence with Rito las Trampas
3	6.7 to 9.1	Confluence with Rito las Trampas	Confluence with Rito los Esteros
4	9.1 to 10.2	Confluence with Rito los Esteros	Confluence with Rio Valdez

[6] Hydrologic Unit Code (HUC) is a designation used to identify and describe watersheds.
[7] Listed as a Sensitive Species by the Santa Fe National Forest (1999), and as a Species of Concern under the Endangered Species Act.
[8] Cut-Bow Trout and Rainbow Trout – Cutthroat Trout hybrids.

5	10.2 to 10.9	Confluence with Rio Valdez	Confluence with Rito del Oso
6	10.9 to 12.4	Confluence with Rito del Oso	Unnamed tributary entering from the North
7	12.4 to 14.3	Unnamed tributary entering from the North	Unnamed tributary entering from the North
8	14.3 to 17.8	Unnamed tributary entering from the North	Unnamed tributary entering from the North
9	17.8 to 18.3	Unnamed tributary entering from the North	Valley widens above a natural fish barrier
10	18.3 to 19.3	Valley widens above a natural fish barrier	River Headwaters

The Rio Mora is a high tributary to the Pecos River, which has its headwaters a few miles west of those of the Mora. The Mora watershed is located primarily in the Pecos Wilderness area, and so has virtually no motorized use and limited access. The primary users of the watershed are recreational – campers, anglers, equestrians, and hunters – although cattle grazing has been practiced for many years to noticeable effect in some areas.

The upper 2 miles of the stream are considered to be habitat for RGCT, although the uppermost mile of the stream, which begins at a sizable natural fall creating a likely barrier and an evident deterrent to upstream migration, does not appear to have any fish present. This observation was affirmed by the results of an electro-shock survey conducted in this area in the summer of 2006 by the New Mexico Department of Game and Fish[9]. Non-native trout species such as rainbow and brown trout are abundant throughout the rest of the streams length, with Brown trout the dominant species. Non-native White Suckers were observed during a snorkel survey conducted in Reach 2.

Throughout most of the river's length, the channel is characterized by long riffles over a cobbled streambed (see Photo 4) punctuated by plunge pools varying in size from quite large and deep (up to 7' deep) to small (see Photo 5), but similar in that most were created by water falling over a stream feature such as a bedrock chute, boulders from a nearby scree/boulder slope, or from Large Woody Debris (LWD) which has become incorporated into the channel bottom.

Photo 4 – Cobbled streambed and plunge pool.

[9] This information was attained through conversation with Conservation Officer Phil Howe.

Habitat Characteristics

The 19.9 surveyed miles of the Rio Mora are divided into 351 Natural Sequence Order Habitat Units (NSO's). The 148 pool habitats comprise 5.7% of the stream habitat length. Riffle habitat comprises 155 NSO's which comprise the vast majority – 89.8% - in the Rio Mora (see Table 4). Other habitat types include tributaries and side channels, which comprise a combined 13.6% of the survey length. Because the stream is primarily located in the Pecos Wilderness Area, there are no significant man made features such as culverts or artificially chanelized reaches, although a small number of fishing weirs are present near the confluence and in the Mora Flats section of the stream.

Table 4 - Habitat Characteristics

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length (%)[10]	Stream Habitat (%)[11]
Pool	148	6250	5.7	**42.2**
Riffle	155	99253	89.8	**44.2**
Tributary	11			**3.1**
Side Channel	37	5031	4.6	**10.5**
Total	**351**	**110534**	**100**	**100**

When compared to the matrix of factors and indicators of stream condition for historic and occupied Rio Grande cutthroat trout streams, the Rio Mora is properly functioning in all aspects other than pool development (see Table 5).

Table 5 - Stream habitat conditions as evaluated by the matrix of factors and indicators of habitat condition for historic and currently occupied Rio Grande cutthroat trout streams.

Factors	Indicators	Rio Mora Conditions
Water Quality	Temperature 3-Day Average	**Properly Functioning**
Salmonid Development	Temperature 7-Day Average	
Habitat Characteristics	Riffle Sediment	**Properly Functioning**
	Large Woody Debris	**Properly Functioning**
	Pool Development	**Not Properly Functioning**
	Pool Quality	**Properly Functioning**
Channel Condition and Dynamics	Stream Bank Condition	**Properly Functioning**

The vast majority – 89.8% - of the Rio Mora is riffle habitat. Although this suggests that there is little to no pool habitat, this is in part due to the survey procedures which specify that in order for a pool to be considered an NSO it must be channel-spanning. There are numerous – albeit uncounted – small pool-habitats created along the edges of the stream which allow fish to utilize pool-like conditions. The dominant type of substrate is cobble, which was estimated as 42.4% of the total stream substrate. This is primarily due to the preponderance of long, shallow gradient, riffles (see Photo 4). Some areas of the stream had anomalous substrate, such as Reach 3 which has high amounts of fine sediment probably due to runoff from the 2002 Estero Fire, and Reach 8 which has lots of boulders from nearby scree slopes and rock-slides. All aspects of the Rio Mora are properly functioning, with the exception of pool development. Despite the paltry number of NSO caliber pools, there are numerous smaller pools which do not meet the survey requirements, but which provide excellent fish habitat.

[10] Percent Stream Length calculated with riffle, pool, and side channels. Tributaries are excluded.
[11] Percent Stream Habitat calculated with riffle, pool, and side channels. Tributaries are excluded.

Table 6 - Summary of habitat and substrate composition in the Rio Mora

Riffle Habitat Summary						
	# of Riffles	**Avg. Length**	**Avg. Width**	**Avg. Depth**	**Avg. Max Depth**	
Entire River	155	750	14.2	1.2	2.3	
Riffle Substrate Summary						
	Sand %	**Gravel %**	**Cobble %**	**Boulder %**	**Bedrock %**	**Total**
Entire River	7.2	21.7	42.4	23.3	5.4	100
Properly Functioning Indicators	<20.0					

Pool habitat is important wintering, resting, and foraging habitat for fish. Pool habitat is evaluated by residual depth and area of pool habitat (length). The pools observed in the Rio Mora have an average residual depth of 1.8 feet. As in the riffles, cobble is the dominant substrate in pools, where it is estimated to account for 37% of the total substrate. Unlike the riffles, sand is prevalent in pool habitat and is estimated at 18.4% of the substrate.

Table 7 - Summary of pool habitat and substrate in the Rio Mora

Pool Habitat Summary											
	# of Pools	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. P.T.C.	Avg. Residual Depth (ft)	# of Pool Miles	# of Pools w/ Res. Depth > 1'	# of Pools w/ Res. Depth > 1'/Mile	# of Pools w/ Max Depth > 3'	# of Pools w/ Max Depth > 3'/Mile
Entire River	148	38.9	16.3	2.9	1.1	1.8	1.2	142	7.3	75	3.85
Properly Functioning Indicators						>1					

Pool Substrate Summary						
%	**Sand**	**Gravel**	**Cobble**	**Boulder**	**Bedrock**	**Total**
Entire River	18.2%	18.4%	37%	14.8%	11.7%	100

Large woody debris (LWD) is related to habitat complexity and the health of fish populations in stream habitats (Fausch and Northcote 1992). LWD density, at 33.8 pieces per mile, is properly functioning in the Rio Mora (see Table 8). Wood classified as medium LWD must be greater than 12 inches in diameter at a length of 35 feet from the large end (or two times bankfull width). Large pieces of LWD have a diameter of greater than 20 inches at a length of 35 feet from the large end (or two times bankfull width). The preponderance of LWD was found in areas where recruitment was facilitated by steep valley banks and a narrow valley floor.

Generally, the banks are in excellent condition, with less than 5% instability. For the most part, this instability was concentrated in the first reach, near the campground, in the meadows below the Valdez, and in the intensively grazed area in the uppermost reach. Each of these three reaches has bank instability in excess of 10% of the total length, which qualifies them as not properly functioning. More intensive management of grazing allotments and heavily used recreation areas might help to alleviate this problem.

Table 8 - Select habitat characteristics of the Rio Mora.

	Pool:Riffle Ratio	**LWD per Mile**	**Total Unstable Banks**	**% Unstable Banks**
Entire River	1:1.1	38.84	6,054	4.1
Properly Functioning Indicators	–	>30	–	<10

Photo 5 - LWD in reach 8, bank instability in Reach 4.

Reach by Reach Comparison

The 10 reaches of the Rio Mora contain different combinations of properly functioning, at risk, and not properly functioning characteristics.

Table 9 - Habitat Characteristics by Reach

Reach	Total Length (mi)	Rosgen Channel Type	Pool Habitat (%)	Riffle Habitat (%)	Side Channel Habitat (%)	Dominant Substrate in Pools	Dominant Substrate in Riffles	LWD per Mile	Bankful Width to Depth	Unstable Banks (%)
1	1.9	AB	3.7	81.8	14.5	Cobble	Cobble	60		10.2
2	5	A	5.9	74.2	19.9	Cobble	Cobble	40.8	14.2	0.8
3	2.4	A	5.5	84.6	9.9	Sand	Cobble	109.2	12	1.1
4	1.1	B	2.7	92.6	4.7	Cobble	Cobble	14.5	8	12.3
5	.7	B	3.8	86.7	9.5	Cobble	Cobble	8.6	7.6	4.4
6	1.5	B	3.1	70.1	26.8	Gravel	Gravel	37.3	9.6	0.5
7	1.9	B	10.4	77	12.7	Cobble	Cobble	41.1	9.2	0.2
8	3.5	B	5.4	69.8	24.8	Cobble	Cobble	38.9	6.2	0.6
9	.5	A	5.2	83.3	11.5	Bedrock	Cobble	38	8.2	0.1
10	1	E	3.7	90.8	5.5	Sand/ Cobble	Cobble	0		11.2
Total	19.5	-	-	-	-	-	-	-	-	-
Properly Functioning Indicators			>30					>30	A,E, G: <12 B,C, F: 12-30 D: >40	<10

The length of pool habitat is of concern in every reach of the Rio Mora. Even the reach with the largest quantity of pool habitat falls short of the properly functioning indicator by 200%. One factor which may explain part of this aberration is related to the survey methodology. In order for a pool to be counted during the survey, the pool must be longer than it is wide, and must also be channel spanning. Throughout the river, many small pools were encountered that did not satisfy this criteria, but which nonetheless provided excellent fish habitat.

LWD is prevalent throughout the length of the Rio Mora and is properly functioning in all reaches but 5. For the most part, LWD values are far in excess of the properly functioning indicator requirements specified in our parameters. These high amounts of LWD reflect the steep, wooded valley sides surrounding the stream that provide lots of available wood as well as ensuring that much of this wood ends up in the river once it falls.

Bankfull width-to-depth ratio in each reach is compared to the expected range for its related Rosgen stream type (see Table 9). Bankfull width-to-depth is not properly functioning in 3 of

the 9 reaches for which these values were collected. In two of these cases, the number was too low for a B channel, which may be due to errors in identifying the stream type.

The majority of the Rio Mora is properly functioning in terms of bank stability, with three reaches categorized as At Risk, and none as Not Properly Functioning. Reach 1 has 10.2% bank instability, which is primarily concentrated in the lowest section which is next to the campground. Reach 4 has 12.3% instability, the worst score along the length of the river, which is due to a combination of grazing and campgrounds (primarily grazing) throughout the Mora Flats. Reach 10 has 11.2% bank instability, and this is entirely due to grazing. Despite having less damage than reach 4 in terms of length of damaged banks, the damage in this reach is more severe where it occurs due to the fragile banks and deep channel in this reach. Excluding these values from overall river instability, the rest of the river has less than 1% instability.

Tributaries

Eleven (11) tributaries contribute to the main channel flow along the Rio Mora. Of these, 5 are named (from mouth to headwaters): Bear Creek, Rito las Trampas, Rito Los Esteros, Rio Valdez, and the Rito del Oso. These streams are more significant contributors than the unnamed contributors, with the exception of one unnamed contributor very near the headwaters which contributes 50% to the flow at that point.

Table 10 - Named Contributors to the Rio Mora and their percent of contribution.

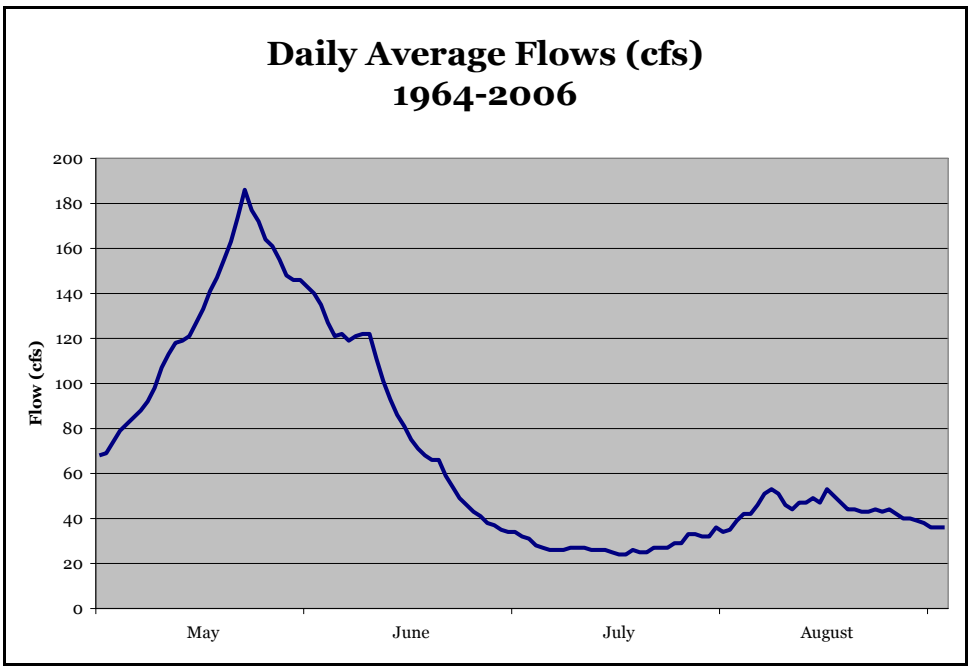
Contributor	% Contribution
Bear Creek	15%
Rito las Trampas	<5%
Rito los Esteros	15%
Rio Valdez	25%
Rito del Oso	20%

Each of the named tributaries marks the end of each of the first 5 reaches, and no other significant tributaries were encountered. During the final days of the survey, in which reaches 9 and 10 were surveyed, numerous small contributors were encountered. These are not included in the total tributary count because of their small size, and the fact that these were found following several days of steady rain and seemed likely to be ephemeral.

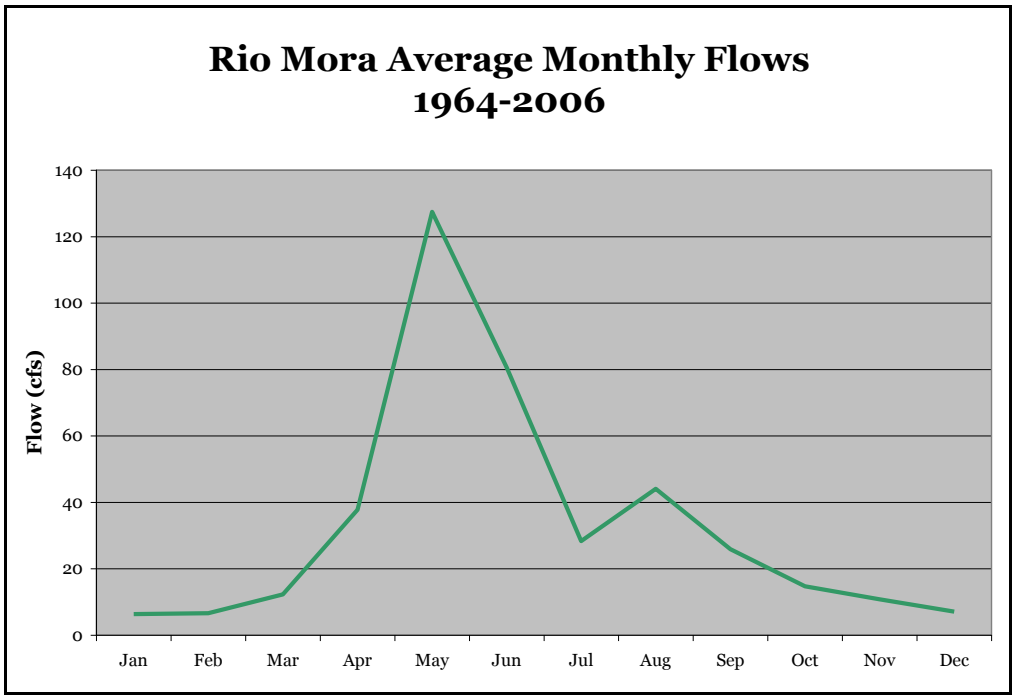
Stream Flow

The headwaters of the Rio Mora are a series of springs in a high mountain meadow. From this point to its confluence with the Pecos River, the Rio Mora is joined by 5 named tributaries and 6 unnamed ones. The largest tributary, the Rio Valdez, contributes 25% of the overall stream-flow at its confluence with the Mora. Based on annual flow patterns, the peak is in late spring and indicates that the majority of the stream-flow comes from snow melt. Usually, this study would include measurements taken using a flow meter. However, at the time of this study, this piece of equipment was malfunctioning and was not used. Fortunately, this particular stream has a USGS gage station (Rio Mora near Terrerro, NM – 08377900) located a few hundred yards upstream from the stream's confluence with the Pecos. Unfortunately, this gage was not active at the time

of the study, but collected data continuously from 1964 to 2006. Data presented in this section is based on average daily and monthly values collected by this gage during its active life.



The flow of the Rio Mora is governed by snowmelt, and spikes in the late spring in late May to early June. Heavy precipitation events later in the summer contribute to a smaller spike in August. These patterns were consistent with general observations made during the survey, which was delayed due to high flows early in the summer and which was conducted in the rain during August.



Water Temperature

Water temperature is a key component of water quality in a stream environment. Combinations of multiple factors determine water temperature regimes in stream habitats. Solar radiation, air temperature, riparian vegetation cover, ground water, stream discharge, channel shape, stream orientation, and climate are some of the environmental factors that influence water temperature. Many chemical and biological processes depend on specific temperatures. Temperature can help determine the suitability of waters for aquatic species such as Rio Grande cutthroat trout (RGCT).

Fish growth, health, and reproduction are affected by water temperature. Fish are very sensitive to water temperature due to temperature specific enzymes. As water temperature increases, so does fish performance. Although fish have increased performance with temperature, they also approach a lethal limit. No lethal temperature information is currently available for RGCT. Another high elevation, arid cutthroat subspecies, Lahontan cutthroat trout (*Oncorhynchus clarki henshawi)*, indicated an upper limit for growth and long-term survival is somewhere between 71.6 and 73.4°F. These temperature limits were based on optimal conditions with high food availability and good water quality, not taking into account the other stressors that may exist in stream environments. It is possible that the actual lethal limits are lower due to water chemistry and other environmental factors (Dunham 1999).

Cutthroat trout reproduction is affected by temperature. Smith et al (1983) compared egg quality of cutthroat trout in a variety of water temperatures. Eggs in cold water were expelled easily and were in good condition. In warm water the eggs were expelled with difficulty, were cloudy or opaque and often broken. Eggs spawned from two-year-old adults exhibited 74% viability in cold water while in warm water only 6.9%.

Forest standards (noted as SFNF in Table 11) are based on seven-day average maximum temperatures and are stricter than the NMED standards. While it is stricter, the Forest standard is more in line with guidelines for salmonid streams across the western United States. This standard allows the SFNF to be more pro-active in improving watershed conditions for native fish as well as ameliorating impairments to water quality before a stream is listed as impaired on the 303(d) list.

NMED standards are based on three-day average maximum temperatures (see Table 11). These standards are based on the Clean Water Act and Total Maximum Daily Loads mandate for water quality standards but are defined by needs for a successful coldwater fishery. Forest temperature standards are derived from research done on inland cutthroat trout and salmonid development, whereas NMED standards are based on research for non-native salmonids (i.e. brown trout, rainbow trout, and brook trout). Data between June 1st and September 30th is used for maximum water temperature standards analysis to identify high temperatures that occur in summer months (see Appendix A, Figure 1).

Table 11. Santa Fe National Forest and New Mexico Environment Department Water Quality Temperature Standards 2002.

Water Temperature Standards	Properly Functioning	At Risk	Not Properly Functioning
SFNF 7-Day Average Max.	≤ 64 °F	64 to 70 °F	> 70° F
NMED 3-Day Average Max.	< 68 °F	68 to < 73.4 °F	≥ 73.4 °F

The temperatures measured in every reach of the Rio Mora were well below levels of concern for trout habitat. The average temperature for the entire river was 47.4 °F during the survey, and the highest recorded temperature – recorded in reach 1 where the campground has removed most of the tree canopy – was 57 °F, well below at risk levels. These low temperatures are likely due to a combination of the geography and the heavy foliage present throughout the stream. Throughout the river, the stream is located at the bottom of a deep canyon and is heavily shaded by willow and overstory canopy. Cold water may impair the productivity of fish species, but it may assure the ability of this stream as a refugia for trout in the face of potential climate change.

Riparian and Upland Vegetation

Riparian vegetation serves many important functions including water purification and storage, erosion reduction and more. Riparian vegetation helps store water in stream banks, increasing available water and stream flow duration; and improves stream bank stability, reducing erosion and its associated fine sediment inputs (Brodie 1996). Riparian vegetation is important in maintaining a healthy fish population in the Rio Mora.

Rio Mora riparian vegetation includes a variety of native and nonnative species. Native riparian vegetation includes alder, willow including the Arizona Willow, and cottonwood species. In some upper riparian stretches a variety of disturbances, including grazing pressures and an altered fire regime, have allowed an increase in coniferous species in what were historically riparian woodland sites (Sarabia 2002).

Several plant species in the Pecos River watershed are listed on either the federal Threatened or Endangered Species List or the Regional Sensitive Species List. The only endangered plant species in the area is the Holy Ghost ipomopsis (*Ipomopsis sancti-spiritus*). Known range of this species is only in the Holy Ghost Watershed, on the border of the surveyed area. It is possible that its range extends into the survey corridor. The sensitive species include the Arizona Willow (*Salix arizonica)*, Chiricahua (bloomers) dock (*Rumex orthoneurus)* and the hairless (Pecos) fleabane (*Erigeron subglaber)*.

Beaver Activity

Evidence of the presence of beavers was encountered in three locations along the Rio Mora. The first of these was encountered in reach 2. Roughly half a mile upstream from the point where trail 242 crosses the Rio Mora, a flooded meadow on the left bank had at least four beaver-created tiers and the largest felled tree was at least 18" in diameter. The second encounter with beaver evidence occurred in reach 4 where a smaller, and possibly abandoned, beaver dam blocks a side channel on the left bank a few hundred yards upstream from the confluence of the Mora and the Rito los Esteros. The final section showing evidence of beaver activity was in reach 6. This site was the most extensive beaver system along the river and extended over a quarter mile along the stream. This area contained at least five large beaver ponds along the right bank which are connected by a marshy meadow full of slides which the beaver seem to use to reach the river and travel between pools. The dams holding the ponds varied in height from 18" to 4' and the longest was 100' long. Two of the pools were channel spanning, and the others were located on the right bank of the river. The channel spanning pools were sandy bottomed and had extensive fish activity

Photo 6 - Snorkeling in a beaver pond. (Reach 6)

While the beaver's role in watersheds has not always been encouraged, studies over the last few decades conclude that beavers are a critical component to increasing stream integrity as well as biotic productivity within the stream and floodplain. Beaver dams were methodically removed from streams on public land until recently (FS Files).

Beavers have many influences on stream systems, surrounding riparian vegetation, and fisheries populations. Beaver-caused stream impacts are considered to be generally beneficial to trout habitat and an asset to stream systems and include increased water storage and aquifer infiltration. The decreased stream velocity that occurs in pool habitat, such as beaver ponds, decreases the water's ability to carry sediment suspended in the water column. Suspended sediment tends to settle into a pond's substrate, creating a sink for stream sediment and reducing turbidity. Sediment transport has been reduced by as much as 90% in studied streams (Olson and Wayne 1994).

Photo 7 - Beaver pond near the Rio Mora. (Reach 6)

Nitrogen- and phosphorus-containing sediments also settle, making beaver ponds a nutrient sink for a stream system. The storage of nutrient laden soil in sediment reduces eutrophication in nutrient-rich systems. In low-nutrient systems, such as headwater streams, the nutrient storage in pond sediment creates a time-release system increasing productivity. After the beaver leaves an area and the pond drains, the nutrient-rich soil is utilized by riparian vegetation to produce dense riparian areas (Allen 1983).

Decreased water velocity caused by beaver ponds alters the carbon cycle of streams. Reduced water velocity combined with increased water temperatures allows macroinvertebrates and bacteria to break down organic matter (leaves and wood) at a faster rate, creating dense macroinvertebrate populations. The breakdown converts organic matter to sediment and in some cases methane gas. The increased bacterial action reduces dissolved oxygen levels within the ponds and immediately downstream. The decreased velocity combined with increased width and overall surface area of the beaver ponds increases stream temperatures. The reduced concentration of dissolved oxygen and increased temperatures usually does not reach levels of concern for trout in Rocky Mountain streams (Gard 1961).

Beaver activity also has an effect on the riparian vegetation within proximity of the ponds, as well as the water table. Beaver activity increases the surface area of ponds by several hundred times, which is highly influential on the surrounding riparian vegetation (Clements 1991). The increased surface area allows for storage of water in the banks and floodplain. The storage of water in the soil and floodplain increases the water table and stores water for times of low flow. During late summer low flow conditions, water stored in the banks provides cool water to moderate flow and extreme temperatures (Parker *et al*. 1985).

While storing water, beaver dams also reduce extreme flows and related disturbance. The dams moderate flow during flood periods. This moderation reduces bank erosion related to flood events, improving bank stability in downstream areas (Olson and Wayne1994).

Beavers consume large quantities of riparian vegetation or woody supplies in their diet, as well as for the construction and maintenance of their habitat. Consumption rates for beaver populations can be higher than the regeneration rates of riparian vegetation. Beaver tend to occupy an area until the surrounding supplies are consumed and then move on to a new section of river within or outside of the watershed. Once a beaver leaves, high nutrient content in the area allows for fast regeneration of consumed riparian vegetation. Over time, the area will regenerate and be ready for a beaver to return (DeByle 1985).

Cutthroat trout in Rocky Mountain streams tend to be most abundant in streams with beaver ponds. Beavers do several things for fisheries habitat: provide a food source, moderate stream temperatures, as well as increase habitat volume and over wintering habitat. Trout biomass and individual size increases with the presence of beaver dams. One possible explanation is high density of macroinvertebrates involved in the decomposition of organic matter and consumption of bacteria. Macroinvertebrates are a key food source for many trout, including RGCT. Increased pool volume, a vital habitat feature for trout, could also contribute to the correlation of healthy fish populations and beaver ponds. Over wintering habitat is also provided by the deep pools created by some ponds. The deeper pools become a refuge for fish when riffle habitat is frozen and can determine the carrying capacity of a stream. Flow and water temperature moderating effects that are caused by increased water tables provide cool water to the stream

during low flow conditions. This could further increase the fish population carrying capacity of the stream (Olson and Wayne 1994).

Fisheries

As with most of the rivers in New Mexico, extensive stocking practices with non-native trout species has led to a drastic change in species assemblages. Historically, Rio Grande cutthroat trout (RGCT), *Oncorhynchus clarki virginalis*, was the only trout found in the Rio Mora watershed. This cutthroat subspecies is currently listed as a sensitive species on the Santa Fe National Forest and is under review for ESA candidate status.

RGCT have been eliminated from the Pecos River by exotic trout. Exotic trout species have been stocked in the watershed since as early as 1896, with Forest Service records dating back to 1959. Between 1959 and 1964 the Mora and Pecos Rivers were stocked with rainbow and brown trout (FS Fisheries Files; see Table 12).

Table 112 - Historical Trout Stockin in the Pecos River Watershed.

Fiscal Year July 1-June 30	Brown Fry	Rainbow Less than 6"	Rainbow Greater than 6"
1959-60	19,925	21,200	4,356
1960-61	7,087	20,000	4,361
1961-62	8,448	20,000	5,344
1962-63	8,640	20,000	3,796
1963-64	8,505	50,000	4,924

The last time NMGF stocked brown trout in the Pecos River was 1980. Approximately 510,000 brown trout were stocked. Rainbow trout are currently stocked in the Upper Pecos River. In 2001, 26,881 fish between 8 and 10 inches were placed in the Pecos River with approximately 50% of them above Holy Ghost. In 2002 the number of rainbow trout decreased to 22,643 fish between 8 and 10 inches (Fry 2003).

The large number of exotic trout stocked in the Pecos River placed pressure on native trout and has led to the fragmentation of their population and subsequent extirpation of many of these fragmented populations. The exotic trout displaced the native population through competition for resources, hybridization and predation. Brown trout is a piscivore, consuming fish like RGCT, and they also compete with native fish for food and living space in the river. A characteristic such as higher temperature tolerance (80.6°F) (Sublette et al. 1990) increases the brown trout's success over native trout in water where temperature is an issue. Rainbow trout present a different threat because they freely hybridize with RGCT and threaten genetic purity of native populations (Sublette et al. 1990). Conflicts with exotic trout species are one factor that has defined the RGCT as a sensitive species for the Forest Service.

Three USFS snorkel surveys were conducted during the summer of 2006 to investigate the fish population in the Rio Mora (see photo 9). One hundred and seventy five fish were observed, and brown trout were found to be extremely dominant both in numbers and were found throughout the surveyed length. Suckers were observed in the lowest pool of survey, and although Rio

Grande cutthroat trout were encountered while fishing in the uppermost reaches of the river, these were not encountered during snorkel surveys.

A previous survey conducted in the summer of 2005 by NMDG&F revealed that the uppermost mile of the river – which had previously been considered RGCT habitat – did not encounter any fish while electro-fishing (Howes, 2007). This may be due to the river either going dry or freezing solid from its headwaters to a series of natural fish barriers located (see photo 10) from 1.5 – 2 miles downstream.

Photo 8 - Two barriers located in reach nine which may be the final barrier to all fish in the stream.

Tests conducted by the New Mexico Department of Game and Fish have revealed several populations of RGCT in the Rio Mora watershed. Existing RGCT populations of the Rio Mora were tested in 2005 and are considered a core conservation population, meaning that the population is at least 99% pure. A small tributary of the river located near the headwaters was also tested and is considered to be a conservation population, meaning that it is 90% pure or greater. Populations in both the Valdez and Esteros, both large tributaries which join the Rio Mora near the Mora flats, were determined to be core conservation populations with at least 99% purity (Pritchard & Cowley, 2005).

RGCT can hybridize with non native rainbow trout (*Oncorhynchus mykiss).* However, rainbow trout were not found in surveys conducted in upper reaches of the river where brown trout were the only species present, and it is unlikely that a significant amount of genetic mixing is occurring now. It is possible that rainbow trout were more prevalent in the past and that the genetic purity of the RGCT has been compromised in the past.

Two large (12”) white suckers were encountered in a deep (6’+) plunge pool located in reach 2. These fish were not encountered elsewhere in the survey, and this pool is likely the upper extent of their range. Based on the size of the fish, it seems likely that the fish spend the majority of their time in this pool and that they are only able to migrate during high flows.

Table 13 - Fish distribution in the Rio Mora determined by USFS Snorkel Surveys (2006).

Fish Species	Native/Non-Native	Observed Distribution by Reach	Estimated Distribution by Reach
Rio Grande Cutthroat Trout	Native	10	9 and 10
Rainbow Trout	Non-Native	1 - 3	1 - 6
White Sucker	Non-Native	2	1 and 2

Snorkel surveys were conducted in reaches 2, 3, and 6. An additional survey was planned for reach 9 in order to assess the RGCT population, but upon reaching this point in the survey it became clear that the high-gradient nature of the stream did not lend itself to snorkeling. Additionally, visual observation revealed a significant number of brown trout and no RGCT.

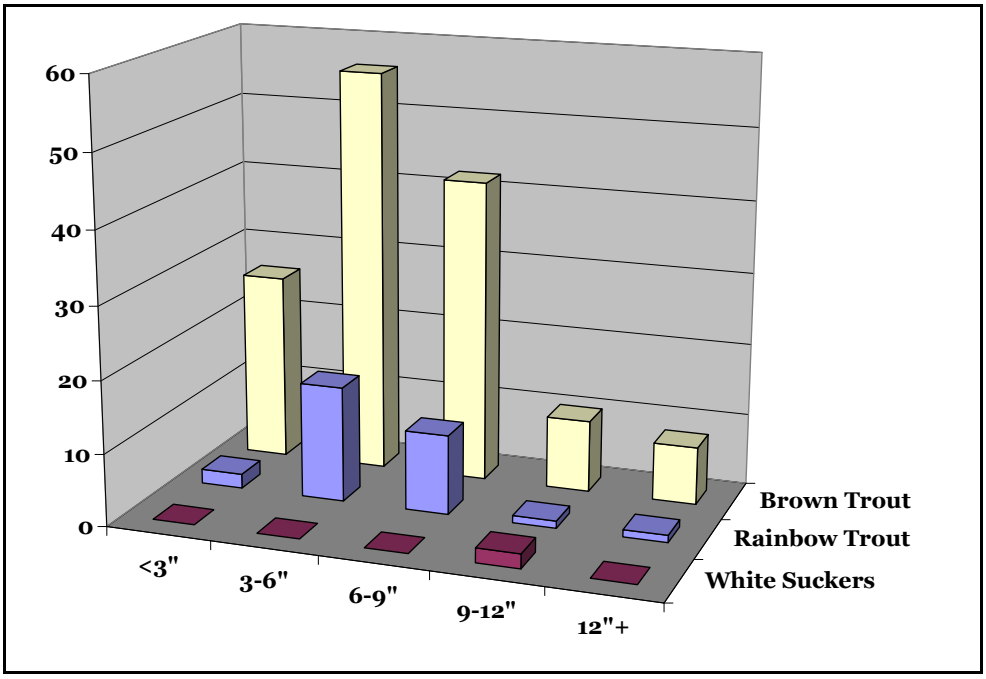


Figure 1 - Species distribution of fish encountered during three snorkel surveys of the Rio Mora

Wildlife Species

A 2002 stream habitat report written about the Upper Pecos River watershed, which is adjacent to the Rio Mora watershed, identifies the area as home to a diverse array of wildlife including two threatened and five sensitive species (see Table 14). The threatened species that is of most concern in the watershed is the Mexican spotted owl. Mexican spotted owl habitat is characterized by cool, steep canyons and mixed conifer forest typical to the Upper Pecos River. No Mexican spotted owls have been observed in the recent owl surveys of the Upper Pecos Watershed, but habitat makes their presence possible.

The 2002 report also identifies sensitive species present in the Upper Pecos watershed including boreal owls that inhabit older spruce and fir forests above 8,000 feet. Potential threats to the owl include removal of tree snags and reduction of prey habitat. Northern goshawks and peregrine falcons are also Forest Service sensitive species that reside in ponderosa pine, mixed conifer, and

spruce-fir forests. While northern goshawks nest and forage in these forests, the peregrine falcons only forage. The northern goshawk is sensitive to habitat loss from logging, catastrophic wildfire and other disturbances especially during breeding season. White-tailed ptarmigan's habitat is above 10,000 feet and is sensitive to human presence and grazing practices. It is not known if the blue-black butterfly is present around the Upper Pecos River. The butterfly was not observed during recent surveys, although the necessary wet meadow habitat does exist. The butterfly's lifecycle is linked to the *Viola nephrophylla*, which grows in wet meadows and near seeps (Sarabia 2002).

Table 14 - Threatened and sensitive wildlife species of the Upper Pecos Watershed 2002.

Species Type	Common Name	Scientific Name	Status
Birds	Mexican spotted owl	*Strix occidentalis lucida*	Threatened
	Boreal owl	*Aegolius funereus*	Sensitive
	Northern goshawk	*Accipter gentiles*	Sensitive
	Peregrine falcon	*Falco peregrinus anatum*	Sensitive
	White-tailed ptarmigan	*Lagopus leucurus*	Sensitive
Insects	Blue-black silverspot butterfly	*Speyeria nokomis nokomis*	Sensitive

Non-listed wildlife can be used as indicators of habitat condition in the Upper Pecos Watershed. Forest Service Management Indicator Species present in the watershed include Rocky Mountain elk (*Cervis elaphus neisoni*), Rock Mountain bighorn sheep (*Ovis canadensis Canadensis*), hairy woodpecker (*Picoides villosus)*, Merriam's turkey (*Meleagris gallopavo*) and mourning dove (*Zenaia macroura*). The elk population in the Upper Pecos Drainage is stable to increasing and is ranked as common with 100 to 10,000 pairs. Elk inhabit most of the area covered in the 2002 Pecos River stream inventory. The bighorn sheep population is considered to be at capacity for the available habitat (USFS, 2002). The sheep habitat is in steep and rocky areas common in the tundra and alpine areas near the headwaters of the Pecos River. The hairy woodpecker population is ranked as abundant in the Forest and breading pairs range from 10,000 to 100,000. The woodpecker can be used as an indicator species for the presence of down logs averaging 17 inches diameter at breast height (DBH) and greater than 30 feet long, which are their foraging habitat. The turkey population in the Forest is ranked as common with 1,000 to 10,000 breading pairs. Ponderosa pine forests and surface water are requirements for turkey habitat common to the lower reaches of the survey. Wild turkeys were observed during the Upper Pecos Stream Inventory near Beatty's Cabin (9,700 ft). The mourning dove population in the forest is ranked as common with between 1,000 to 10,000 breeding females. The dove habitat is abundant and occurs primarily in the lower elevations of the survey (Sarabia 2002).

Stream Improvements

The majority of the Rio Mora is located in the Pecos Wilderness area and has very few stream improvement structures. The only area of the river which is located near a road is just above the confluence with the Rio Pecos. This section of the river is unlikely to be referred to as "improved" due to nature of the campground located along the left bank of the stream. Within the lowest half-mile of the Rio Mora, improvements include a single bridge located 50' from the confluence, a USGS gage station (recently inactive, number 8377900 – Mora River near

Terrerro, NM) located 600' from the confluence, and a few log-weirs which appear to have been installed by the Forest Service. Once the stream enters the wilderness area, there are no more constructed features with the exception of 4-5 more small log-weirs located near the Mora Flats. The weirs located in the flats appear to be a mix of user-created and Forest Service installed structures.

LAND USE

This historic description is taken from portions of the Brazel Prescribed Burn report by Jeremy R. Kulisheck, and written by Brent Able and William Barfuss (2003) from the Santa Fe National Forest Heritage Program.

Paleo-Indian use of the upper Pecos Valley appears to have been minimal. Nordby (1981) suggests that this may be due to the absence of game species, such as bison, in the area prehistorically, but current research indicates that few contemporary hunting and gathering camps actually focus on the hunting of large game (Cordell 1979; Tainter and Gillio 1980). The base of a Paleo-Indian point has been located in the high country of the Pecos Wilderness area during recent surveys conducted by the Forest (Abel 1989a). This artifact was found on a Late Archaic/Basketmaker site and may be a curate item.

A few Archaic Period (5000 B.C. - A.D. 1) lithic sites have been recorded in the area. These sites are frequently found on high benches above major watercourses (McGrary 1983). The warmer and drier climate of this period is thought by some to have contributed to the extinction of larger game animals, while artifact assemblages reflect the hunting of smaller species.

The first known sedentary community in the upper Pecos Valley, near the present Pecos Pueblo, was occupied ca. A.D. 800. Excavated pithouses have yielded evidence for the use of maize, wild plants, mule deer and antelope (Nordby 1981). Agricultural fields were typically situated on the lower terraces above Glorieta Creek. Despite evidence for sedentary and semi-sedentary occupation between A.D. 800 and 900, no increase in valley population seems to have occurred until approximately A.D. 1200-1300.

About A.D. 1200 population size increased, resulting in establishment of larger communities, such as Forked Lightning Ruin, Dick's Ruin, Hobson-Dressler Ruin, and Black-on-White House, over which the pueblo of Pecos was later built. Farming, hunting and gathering continued to be the economic base of the valley, but outlying fields and associated fields and field houses suggest that there may have been pressure to expand agricultural land to boost crop production (Nordby 1981).

By the Pueblo IV period (A.D. 1300-1600), large multi-storied communities such as Pecos Pueblo, Arrowhead Ruin, Loma Lothrop and Rowe were thriving. These towns had hundreds of rooms, preplanned plazas and large populations. Irrigation was employed for agricultural production and there was apparently an increase in the use of the field house strategy (Nordby 1981). During this period, trade relations with the Plains Indians seem to have been firmly established. The valley, with its access to Plains and Rio Grande populations, became a well-known trade center by the time the Spanish arrived to the area.

By A.D. 1450, Pecos Pueblo was the only occupied village in the valley. The architectural style and location of Pecos have been interpreted as defensive, and Kidder suggests that raiding Plains

Indians may have been the cause for the abandonment of nearby pueblos (Nordby 1981). Yet predatory nomads such as the Apaches probably did not arrive in the area until much later, which leads other researchers to suggest that the other villages consolidated in order to supply labor for irrigation or that warfare may have been endemic in the region (Nordby 1981).

Europeans first visited Pecos Pueblo during Coronado's exploration of the upper Rio Grande valley in 1540 (Jenkins and Schroeder 1974). The Pueblo was next visited by the Rodriquez-Chamuscado expedition in 1581 and the Espejo- Beltran expedition in 1582. Castano de Sosa captured the pueblo in 1590 and the defeated inhabitants fled (Kidder 1962). Castana de Sosa soon left and Europeans did not visit the pueblo until Onate's colonization of New Mexico in 1598. Sometime between 1598 and 1620, a mission was built and used until the Pueblo Rebellion in 1680 (Kidder 1962), when the Spanish evacuated the territory (see Photo 13).

Photo 9. The Mission at the Pecos Pueblo as it looks today.

During the Spanish absence, conflict between the Pecos inhabitants, the Tanos to the west and the Tewas to the north may have led to the abandonment of several Tano towns (Kidder 1962). When De Vargas reoccupied New Mexico in 1692, the Pecos inhabitants fled once again, but they soon returned and another mission was built at the pueblo. In 1750 a war party seeking Comanches may have been ambushed, resulting in the death of most of the adult male population of Pecos (Kidder 1962). A smallpox epidemic struck in 1788 leaving only 180 survivors. Other diseases spread through the community until, in 1838, the remaining 17 occupants moved to Jemez Pueblo (Kidder 1962).

In the 1790's Spanish settlers began to use the area, and by the early 1800's there were several hundred families in a dozen tiny placitas within the river valley (Meining 1971). Trade between the United States and Mexico was established by 1822, and the Santa Fe Trail passed through the Pecos area and Glorieta Pass.

New Mexico became a United States territory in 1846. Since that time the area has been exploited by both Anglo and Hispanic populations for the available timber, mineral and grazing resources.

Between March 26-28, 1862 the key battle of the Civil War in the western U.S. territories took place near the present town of Glorieta. The final battle took place in a series of skirmishes on March 28, 1862 in and around Glorieta Pass near Pigeon's Ranch located along present day Highway 50. Confederate troops were attempting to pass through the area to attack the Union's stronghold at Fort Union, located about 30 miles north of the town of Las Vegas along the Santa Fe Trail, but they were met by Union troops (mostly Colorado volunteers) at this narrow pass (Kennedy 1990, p. 28). Both sides suffered about the same number of casualties, but approximately 500 Union soldiers managed to cross over Glorieta Mesa and destroy the Confederate's poorly guarded supplies at the other side, causing the Confederates to retreat, and leaving the New Mexico Territory under Union control (see Edrington and Taylor 1998, chapter 8).

In 1882 the claim that ultimately brought modern industrial mining to the area was first worked by a group of men who organized themselves into the Pecos River Mining Company at Terrero. They found a vein of high quality copper laced with gold and silver and lots of zinc. The ores were hauled to El Paso and sometimes rejected due to the high zinc content. As a result the mine operated intermittently and made no one rich (de Buys 1985).

The company passed into the hands of Goodrich Lockhart Company in 1916 and to the American Metals Company in 1925. American Metals gambled a tremendous amount of capital on the Terrero operations and it paid off. Over the next 13 years the company extracted more than 37 million dollars' worth of ore, and for 12 of those years the mine was New Mexico's leading producer of zinc, gold, lead, and silver. During the boom years the mine employed some 600 workers and reached a depth of 1,750 feet. It consumed six million board feet of timber for shoring per year, and relied upon what was then the longest aerial tramway in North America, to transport its ore in half ton buckets from the mine to a crushing mill 12 miles away in Alamitos Canyon (de Buys 1985).

Terrero boasted a population of 2,500 but the Great Depression brought hard times to the mine and to the underpaid and overworked miners. Labor unrest culminated in a three-month strike in 1936. This factor and engineering difficulties caused the mine to close down in 1939 and with that Terrero became a ghost town (de Buys 1985).

The Pecos River Forest Reserve, comprising most of what is now the Pecos Wilderness (deBuys 1985), was established by proclamation of President Harrison on January 11, 1892. It was the fourth Forest Reserve established in the United States and the first in the Southwest. In 1908 it became the Pecos National Forest (Baker et al. 1988) and in 1915 the Jemez and Pecos National Forests were combined to form the Santa Fe National Forest (deBuys 1985), the second oldest of all National Forests in existence today (Barker 1985). Most of what was the Pecos River Forest Reserve and the Pecos National Forest became the Pecos Ranger District.

The Great Depression left large segments of the work force unemployed. Under the administration of Franklin D. Roosevelt, a number of New Deal programs, designed to relieve problems of unemployment, were initiated. One program, which addressed the problem of unemployment in combination with various national conservation needs, was the Civilian Conservation Corps (CCC). The CCC was established in April of 1933 and terminated, due in part to U.S. involvement in World War II, in 1942. Over 50 percent of all CCC public works projects were administered by the Forest Service and included erosion control measures, forest pest and disease control, fighting forest fires, and construction of numerous physical facilities (Otis et al.1986).

In the Southwestern Region of the Forest Service, initial plans called for 51 CCC camps, 23 of which were to be in New Mexico. Over the life of the program, on the average, 20 camps operated in the Region until the CCC program was terminated in 1942. Four camps were opened on the Forest. The Glorieta Mesa CCC Camp, located a few miles west of Pecos, was one of those.

Summarized from Michael Dussinger, Coyote District Archaeologist

Human occupation of the watershed and north central New Mexico is documented from the Paleoindian Period (ca. 10000 B.C. to 5000 B.C.) to the present. The cultural history of this portion of the state reflects the unique regional location of the area, which is transitional between the Colorado Plateau Province and the Southern Rocky Mountain Province (Fenneman 1931).

Paleoindian (ca. 11500 B.C. to 5000 B.C.) and Archaic (ca. 5500 B.C. to A.D. 200)

Paleoindians are thought to have lived in small, mobile bands that moved across the landscape with some frequency to hunt now extinct mega-fauna, including mammoths and bison. Subsistence was supplemented by the hunting of smaller mammals and gathering of wild plants (Cordell 1979). These nomadic hunters probably developed a much broader hunting and gathering subsistence strategy during the Archaic in response to climatic changes that occurred at the end of the Pleistocene (Irwin-Williams 1979). Archaic populations most likely lived in small groups for most of the year, moving often and exploiting a wide variety of wild plants and animals with the changing seasons (Stuart and Gauthier 1981). Later Archaic subsistence strategies included horticulture as well.

Ancestral Eastern Puebloan (A.D. 600 to A.D. 1540)

The Ancestral Eastern Puebloan Period is most often characterized by a dependence on agriculture (supplemented by hunting and gathering), use of the bow and arrow, ceramic production, pithouse to large pueblo architecture, population increase, sedentism, changes in political and social organization, and nucleation of populations in large villages.

The early Puebloan Period is defined by a shift in subsistence strategies. Sites in the Upper Rio Grande area tend to be small and dispersed, and occupation appears to be seasonal and short term. Puebloan sites from the latter half of this period are larger and denser and show new ceramic and architectural styles, including aggregation into masonry or adobe room pueblos (Cordell 1979). During this period lower elevation areas were at times abandoned and highland areas were more intensively utilized (Stuart and Gauthier 1981).

Historic/Pueblo V (A.D 1540 to present)

The Historic Period, also called the Pueblo V Period, is characterized by larger pueblo sites, substantial population movement (Stuart and Gauthier 1981) and the arrival of the Spanish.

North central New Mexico experienced the full extent of the impact of Spanish culture with the Coronado expedition of 1540 and the Oñate expedition of 1598 (Hill 1990). The introduction of European diseases, new religion and economic systems, warfare, and famine severely reduced Native American populations and settlements in the region from the late 1500s through the

1600s. Following the Pueblo Revolt of 1680 and Diego de Vargas' subsequent Spanish reconquest in 1692, the Spanish established more missions and more settlers started utilizing the area for cattle grazing, farming and hunting. The Spanish government granted free title tracts of land to Spanish colonists to promote settlement and land development in northern New Mexico. Grants were also made to Pueblo Indian groups (Scurlock 1981).

Hispanic settlement north of Abiquiu grew in the early 19th century. The community of Gallina, originally called Jacquez, was settled northwest of the Polvadera Creek Watershed in 1818 by Antonio Ortiz (Julyan 1995). The community of Coyote has its roots in the settlements of Coyote Valley and Coyote Canyon that were established around 1862 (Julyan 1995). The community of Llaves, originally named Maestas, was established in the early 20th century. These small communities, along with Youngsville, continue to subsist to some extent on the extraction of resources from the land, including cattle and sheep ranching, logging, and farming.

While Spanish rule of the region came to a close in 1821, new markets for wool and sheep brought increased colonial sheep herding and the development of large commercial sheep operations. Settlements in northern New Mexico grew until the U.S. annexed New Mexico in 1846. The 1848 Treaty of Guadalupe Hidalgo included a promise to honor all valid pre-existing Spanish land grants, but many of these were nullified or reduced with the involvement of the U.S. Government, land speculators, and lawyers. According to sociologist C. Knowlton, "Much of the land now included in the National Forest System in northern New Mexico was once part of the many Spanish and Mexican land grants in the region. When the Forest Service acquired these lands, these use rights were not acknowledged. The loss of grazing lands and the resources of the mountain forests brought poverty to a large number of Spanish-American village people" (Knowlton 1970). Shepherds found themselves at the mercy of landowners and many became tenant herders.

Roads

Fish habitat degradation can result from poorly planned, designed, located, constructed, or maintained roads (Furniss *et al.* 1991). Even in good condition, roads can introduce large quantities of sediment to streams (Grayson *et al.* 1993). The increased fine sediment concentrations that result from high road densities have been associated with decreased fry emergence and juvenile densities, loss of winter carrying capacity, and increased predation of fishes. The introduction of fine sediment has also been related to the reproductive degradation in salmonids. Survival of incubating salmonids from embryos to emergent fry has been inversely related to the proportion of fine sediment in spawning gravels (USDA FS 2000). The only roads located in the Mora Watershed occur very near the confluence of the Mora and the Pecos – NM Route 63 and the dirt access to the campground and trailhead for trail 240. The impact of these roads is minimal on the Rio Mora.

Recreation

The Rio Mora is in the Pecos Wilderness for the majority of its length. As such, there are no access points for motorized recreation. There are four possible access points for hikers, equestrians, and anglers: the Grass Mountain Trailhead, the Iron Gate Trailhead, the Sparks Trailhead, and by hiking directly up from the campground at the river's mouth. Of these four points, the most heavily used access is from the Mora campground. The first mile of the stream

shows signs of extensive recreational use. Trail 240 begins at the campground, and for the first mile of the stream runs along the river's northern bank. In this section, the trail is braided as users have created multiple trails to avoid some difficult rocky outcroppings, which the trail runs directly over, and at least one large (>30" diameter) fallen tree. This section of trail is also used by cattle, and on one occasion surveyors observed a group pf 20-30 cattle being herded 5-abreast along the narrow trail, resulting in extensive erosion and the rapid widening of the trail. Fishing is also popular in this section of the river, and multiple anglers were present at all times. Additional evidence of fishing included abandoned line and lures.

Photo 10 - Campers in Mora campground.

Trail 240 diverges from the stream after the confluence with Bear Creek, and at this point the only evidence of recreation was light user trails and the occasional angler. Hiking through the following 3-4 miles of stream was difficult due to thick vegetation. At mile 5, trail 248 crosses the river between two steep sets of switchbacks. At the point of the crossing, the stream is large enough that it is necessary to wade, and no users were observed on this trail despite many days of accessing this river via the Grass Mountain trailhead. From this crossing, it is another 3.5 miles until the river enters the Mora Flats and throughout this reach, no evidence of recreation was encountered. This section of the river was one of the most beautiful and pristine, including Arizona willow, Yellow Lady-Slipper orchids, and a large, flooded beaver meadow near the confluence with the Rito las Trampas.

As the river approaches the Mora Flats, it passes near the Trampas fire of 2002. This reach had significant amounts of LWD and was very difficult to hike through. No people were encountered until the Mora Flats, just above the Rito los Esteros.

The Mora Flats is the most heavily used recreational area along the Mora in the Pecos Wilderness. This site is most easily accessed from the Iron Gate Trailhead with a short 3-mile hike. Access is also possible from the more remote Sparks trailhead, which is above Rociada, NM on the eastern side of the mountains. The Mora Flats has a popular campground located on the western side of the Mora north of the point where trails 240 and 226 cross the river. The southern half of the flats appears to be used primarily by cattle,

Photo 11 - Streamside campsite in the Mora flats.

but home-made fishing weirs constructed of logs casually laid in the river testify to the occasional presence of anglers. The campground has between 6 and 10 active sites, most of which have fire rings, and many users were observed over the course of the summer who had either hiked in to stay at that site, or who were spending the first night of their trip at the Flats before continuing up the Rio Valdez on trail 224. Hikers and equestrians appeared to use the area in equal numbers. From this point, the majority of recreation in the watershed appears to occur along the Valdez, although this area was not included in the survey.

Although trail 252 continues up the Mora from its confluence with the Valdez, at the time of the survey this trail was in bad repair and appeared to be seldom used. On one occasion, fishermen were encountered in beaver ponds located 2 miles up the Mora from the flats, but the lack of trail infrastructure suggest that this area is visited infrequently. It would be a difficult day trip to hike in, fish these ponds, and hike back out to Iron Gate.

From the beaver ponds to the headwaters of the river, the stream is very difficult to hike due to a steep gradient, fast flows, thick vegetation, and no existing trail infrastructure. Trail 239 crosses the river within a few hundred yards of its headwaters, but this trail requires several days of hiking to reach and its level of use is difficult to discern due to the preponderance of cattle and grazing-related erosion along the trail and its crossing.

Timber

The majority of the Rio Mora is located in the Pecos Wilderness Area, which prevents large timber sales. The areas of the watershed not located in the wilderness are steep, and topography would prohibit large-scale logging. It is likely that any timber harvesting which occurred in the area was tied to homesteading, and no significant timber extraction has ever occurred (Lujan, personal correspondence).

Fire

Historically, fire has played an important role in the forests of northern New Mexico. The forests adapted to a natural fire regime, which played an important role in the ecology of these systems. The historic fire regime consisted of smaller, more frequent fires that burned at a lower temperature than the current catastrophic, large scale burns. Historic burns reduced the density of trees and shrubs, the amount of dead wood and kept forest fire fuels low. However, human intervention has dramatically altered the historic fire regime. Fire frequency in the Sangre de Cristo Mountains has declined since

Photo 12 - Beggining of Estero burn.

the 1750's, possibly due to intensive grazing and shrub removal (Touchan et al. 1994). Over a century of fire suppression further reduced the fire regime frequency creating an abundance of fuel and increasing the potential for catastrophic fires similar to the 2000 Viveash Fire. Catastrophic fires create larger and hotter burns, dramatically altering the ecosystem.

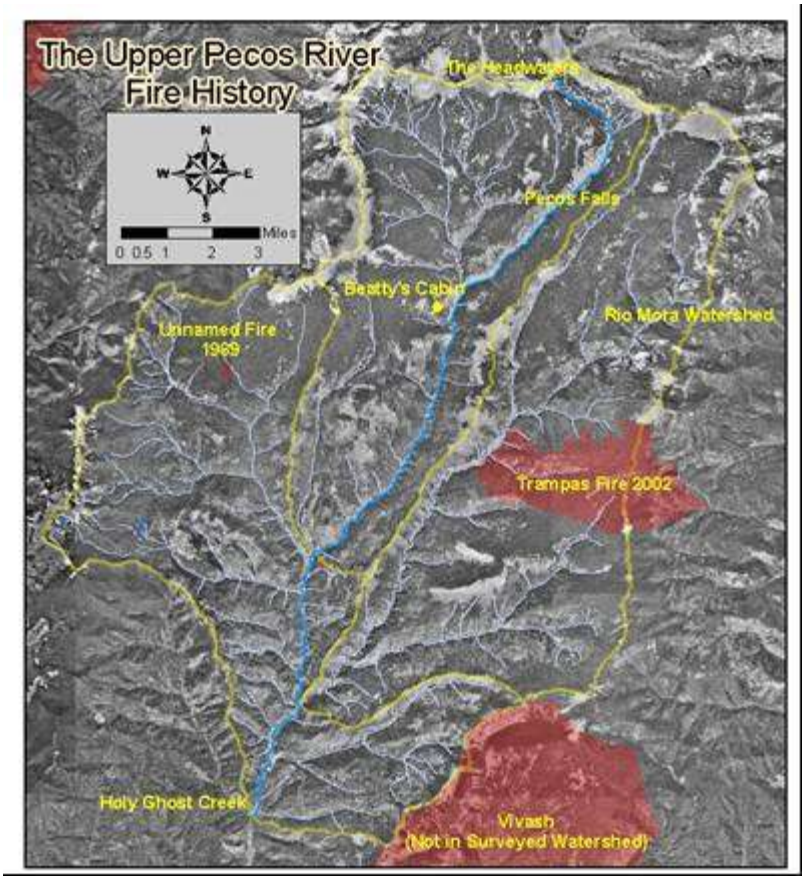


Figure 2. Upper Pecos and Mora Watershed Fire history. Viveash fire was located in an adjacent watershed with little intrusion.

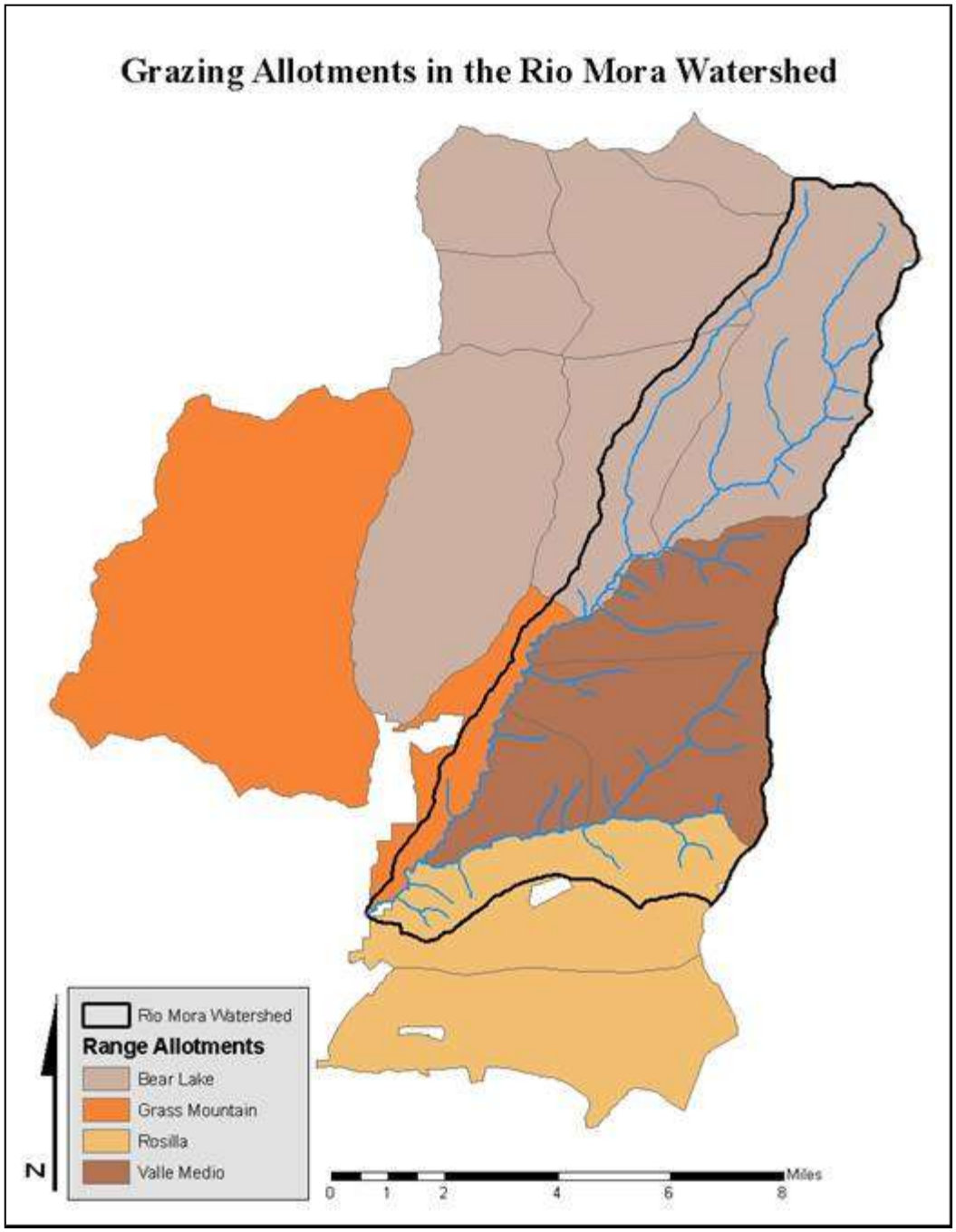
Two large fires have occurred in the Upper Pecos Watershed in recent history. The Trampas Fire of 2002 in the Rio Mora Watershed and an unnamed fire in the Panchuela Creek Watershed (see Figure 7). Trampas Fire, which burnt in the summer of 2002, covered 7.4 square miles in the Pecos Wilderness. Smoke from this fire was visible at the beginning of the 2002 Upper Pecos Stream Inventory (USFS, 2002). The unnamed fire of 1989 was a relatively minor fire, burning 0.1 square miles in the Pecos Wilderness (see Table) . The Viveash Fire of 2000 was located in an adjacent watershed reaching the border of the Mora Watershed. This catastrophic fire covered 45.6 square miles, demonstrating the extreme fire potential in the area.

Table 15. Documented recent Upper Pecos River Watershed fire history. All fires are located within the watershed.

Year	Name	Acres	Square Miles
1989	89l172062438 (Fire ID Number)	39.7	0.1
2002	Trampas Fire	4750.5	7.4

Stock Grazing

Ranching is a tradition and has been a way of life in northern New Mexico since the Europeans arrival in the 1540's (USDA FS 1996). Grazing on public lands has occurred for nearly a century. The Rio Mora Watershed contains portions of four grazing allotments: Bear Lake, Valle Medio, Rosilla, and Grass Mountain. The Valle Medio allotment is located entirely within the Rio Mora Watershed and has an area of 14,231 acres. The Rosilla allotment has a total area of 18,406 acres, of which less than a third is in the Rio Mora Watershed. The Grass Mountain allotment has a total area of 22,768 acres in two pieces. Only a small portion of this allotment – 15 % or less – lies in the Rio Mora Watershed. The Bear Lake allotment has a total area of 41,445 acres, and roughly a third of it lies in the Rio Mora Watershed. Of these allotments, only Bear Lake has active grazing due to the difficulty of access to the sites. An interdisciplinary review evaluated the impacts of grazing in this allotment, and determined that it was not of concern (Lujan, personal communication).


Grazing Allotments in the Rio Mora Watershed
Rio Mora Watershed
Range Allotments
Bear Lake
Grass Mountain
Rosilla
Valle Medio
N
0
1
2
4
6
8
Miles

RECOMMENDATION SUMMARY

Riparian

Objective:

Forest wide goals from the Santa Fe National Forest Plan call for the protection of riparian areas including the achievement of satisfactory conditions and maintenance of conditions currently in good condition (Forest Plan, 20). Specific management goals for riparian areas in the Rio Mora watershed emphasize the maintenance of already excellent riparian conditions, in particular the protection of the natural riparian vegetation community to promote watershed integrity and function.

Concerns:

Three areas of the Rio Mora show signs of degraded riparian health. Two of these areas, the headwaters of the stream and the Mora Flats, show evidence of damage from grazing which impacts riparian vegetative diversity and creates bank instability. Riparian damage from recreational use is apparent in the lowest mile of the stream, and is particularly apparent in the Mora campground, which is located in the riparian zone. Additionally, this area is also the site of a corral used to hold significant numbers of cattle in a concentrated area.

Implementation methods:

1) Grazing practices should be managed to protect riparian areas. Riparian grazing should be eliminated in areas where bank stability is a concern, such as the headwaters area. Moreover, access routes used to bring cattle into pastures located in the wilderness should be modified so that cattle are not led en masse through riparian corridors.
2) Trail maintenance along the river during its first mile should be performed with greater regularity to prevent the creation of user-created paths, which often result in steep climbs denuded of vegetation and highly susceptible to erosion.
3) The Mora campground should be redesigned to encourage more environmentally appropriate camping practices. This should include reconsideration and rebuilding of existing toilet facilities, limiting the number of sites and campers permitted in this campground, and more adequate facilities for garbage and recycling. The overall campground site should be moved back somewhat from the edge of the stream to provide a buffer of riparian vegetation that could help improve bank stability and fish habitat.

Beaver Populations

Objective:

Wilderness management goals from the Santa Fe National Forest Plan are designed to protect native species and to manage in a manner consistent with wilderness values. (Forest Plan, 127) The management objective for beaver in the Rio Mora watershed applies these goals to local, native beaver populations and calls for their protection and expansion.

Concerns:

Existing beaver habitat is well developed and a remarkable resource along the Rio Mora. This habitat is not actively monitored, and were it to be reduced in quality or productivity this could go unnoticed.

Implementation methods:

1) Establish monitoring standards and protocol for existing beaver habitat.

2) Track movements of beaver along the length of the Rio Mora and the vegetative diversity and recovery of beaver meadows.
3) Educate forest users and local community members regarding the benefits of beavers including their role in removing sediment from the river, increasing hydrologic infiltration, improving vegetative and structural diversity along the river, regularizing stream-flow throughout the year, and increasing upstream water storage in the Pecos river system.

Native Fish Populations

Objective:

Forest wide goals specified in the Santa Fe National Forest Plan include the identification, protection, and enhancement of habitat containing threatened, endangered and sensitive species.(Forest Plan, 19) Wilderness goals stipulated in this same plan further emphasize the management of native plant and animal species.(Forest Plan, 127) Consistent with the intent of these goals, the specific management objective for native fish populations in the Rio Mora watershed is to restore and protect populations of native RGCT in their historic range.

Concerns:

The Rio Mora Watershed is home to at least four distinct populations of RGCT. These are located high in the watershed at the uppermost reaches of the Rio Mora and its major tributaries. The limited range of each of these populations places them at risk of extirpation from catastrophic events such as wildfire or drought.

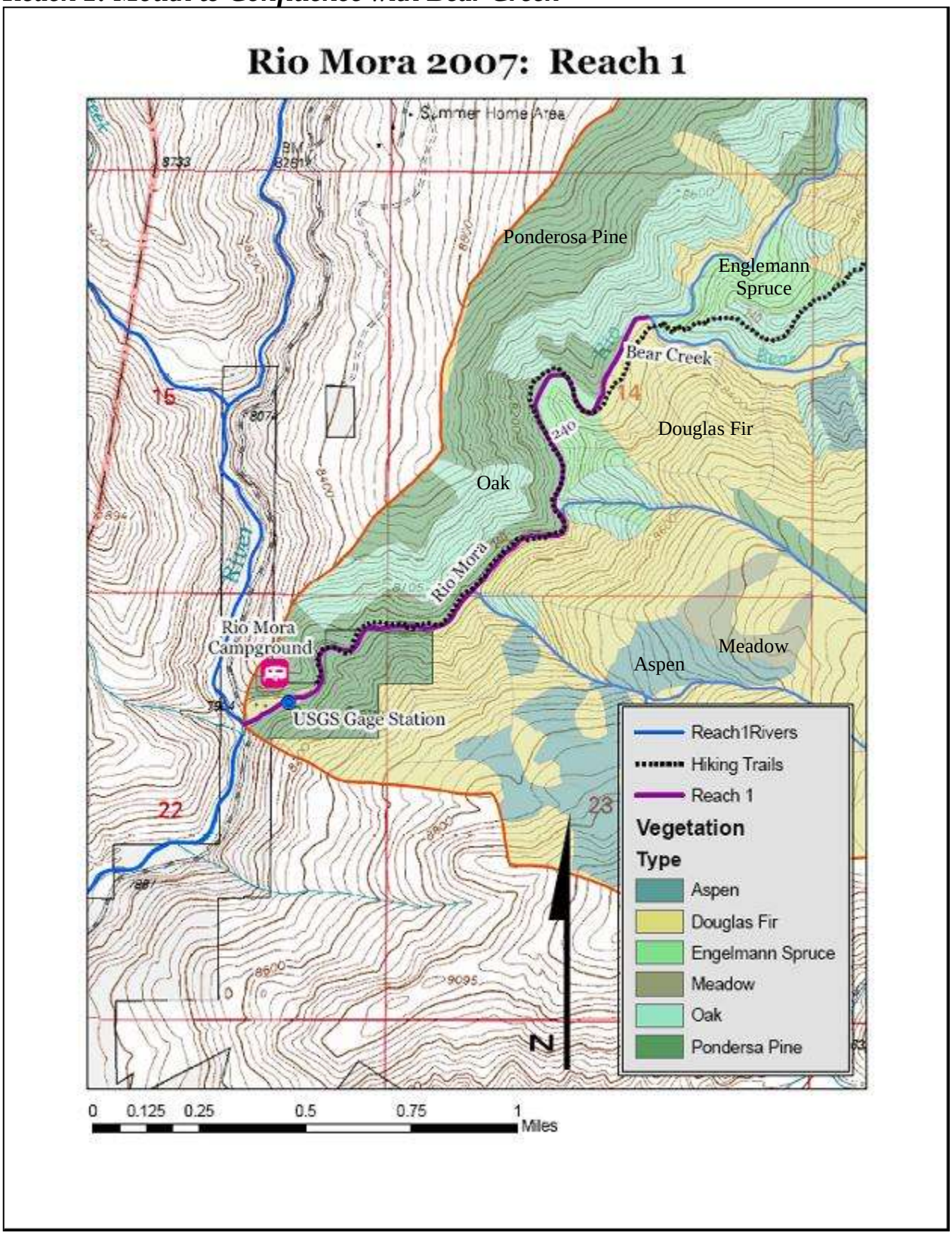
Implementation methods:

1) Identify natural barriers to fish passage or sites where human-made augmentation could create such a barrier with a minimum degree of invasion to the habitat and aesthetics of the river.
2) Partner with the New Mexico Department of Game and Fish and work to remove invasive species from areas above these barriers in an effort to expand the range of RGCT and to link isolated populations of RGCT.
3) Stop stocking non-native fish in the watershed and work with local communities and fishing organizations to promote the recreational and environmental benefits of native trout fishing.

REACH SUMMARIES

Photo 13 - Thick willows in reach 5.

Reach 1: Mouth to Confluence with Bear Creek



Map 2 - Reach 1 Map.

Reach 1 starts at the confluence with the Pecos River. The stream then flows 1.9 miles to the confluence of the Rio Mora and Bear Creak where the Reach was broken due to change in the hydrologic regime. This reach falls under the Rosgen stream types A and B.

At its confluence with the Pecos, the Rio Mora is a wide, shallow, straight stream on a bed primarily of cobbles. State Road 63 crosses the Mora on a bridge 50' upstream from its confluence and both rivers show evidence of heavy foot and vehicle traffic on the banks. Within the first mile the stream narrows, increases in gradient, deepens, and increases in speed. The morphology of the Rio Mora then assumes a rather consistent pattern of long riffles – up to a quarter mile in length - alternating between high gradient, narrow and deep sections on primarily boulder or bedrock substrate, and low gradient, wide, shallow glides over cobble. Pools are generally located after sharp meanders at the base of exposed bedrock cliffs and out-crops. The reach ends 1.9 miles upstream at the confluence with Bear Creek, a tributary that contributes an estimated 15% to the river's flow.

During the first reach the Rio Mora lies in a steep-sided valley. By the upper limit of the reach, the valley deepens to be more of a canyon, with cliff bands, steep talus, and forested slopes. The confinement of the valley makes access difficult, and often the hillsides rise precipitously from the stream bank. The exception is on curves where the inside bank usually has a large flat shelf and an established floodplain.

Photo 14 - Rio Mora Campground.

The Rio Mora is accessed at a trailhead and campground located near the confluence with the Pecos River. The Rio Mora Campground – located upstream from route 63 – is managed by the New Mexico Department of Game and Fish and is heavily used by RV, trailer, and compound-style campers. Effects from the campground are extensive and obvious – particularly on the left bank – including degraded vegetation within the campground, excessive garbage, unpleasant odors, and signs of human waste. This condition extends upstream for approximately a half mile from route 63. The stream banks along the campground, especially the left bank, are heavily eroded from use, and the patterns of use – user-created trails with multiple river crossings – extend for well over a mile above the campground.

Though a formal trail is established in the area, the numerous user trails and the need for trail maintenance make it difficult to discern. Instead, there are many intersecting trails on both banks with numerous (5-10) stream crossings. Prevalent on-trail obstacles such as bedrock out-crops and downed trees have led to the creation of a braided trial section in places – one trail that goes over the obstacle, one or two that go around it, and one that crosses the stream. By the end

of the reach, the braided trails are no longer apparent and a clear primary trail diverges from the river.

Riparian vegetation is abundant and consistent for the majority of the reach. At the beginning near the campground, vegetation suffers from use, but quickly rebounds beyond the campground's main effects. Riparian vegetation is primarily composed of willow (*Salix* spp.), alder (*Alnus tenuifolia)*, birch (*Betula occidentalis*), maple (*Acer negundo*), dogwood (*Cornus stolonifera*), and cottonwood (*Populus* spp.). Riparian vegetation provides adequate shade for narrower sections of the stream. Over the wide cobble riffles however, shade is usually inadequate.

Large woody debris was abundant throughout the reach. Five log-jams are located in the reach and concentrated just upstream from the campground. There are many large downed trees spanning the width of the stream, some of which have substantial collections of small woody debris which impact stream flow and create small pool habitats throughout the riffle.

Photo 15 - Erosion at a river access point near Mora campground.

There are several prominent side-channels during the course of the reach. The most prominent of these enters the Rio Mora on the left bank while still in the campground. This channel is the result of a small spring and numerous small (< 6") rivulets which leave the main channel and are consolidated in a secondary channel comprised largely of walking trails. There are also many ephemeral side channels as well as instances where the main stream braids around semi-permanent willow islands.

The persistence of fishermen at the campground suggests the presence of fish, however fish are much more prevalent further upstream. By the end of the reach fish were consistently seen in side channels and pools. Observations and conversations with anglers and one Warden from the New Mexico Department of Game and Fish (who was fly-fishing the Mora on his day off) suggest that the primary trout species are brown trout, although rainbow trout are also present.

Habitat Characteristics

Reach 1 is divided into 21 NSOs, measuring 2.0 miles (10,893 feet). Eight (8) NSOs are pool habitats, and comprise 38.1% of the stream habitat. Nine (9) riffle habitats make up 42.9% of the stream habitat in Reach 1 (see Table 16).

Table 16 - Summary of Reach 1 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length* (%)	Stream Habitat** (%)	Properly Functioning Indicators
Pool	8	399	3.9	38.1	>30%
Riffle	9	9824	96.1	42.9	-
Culvert	0	0	0	0	-
Tributary	0	N/A	N/A	N/A	-
Falls	0	0	0	0	-
Side Channel	4	670	N/A	20	-
Dry Channel	0	0	0	0	-
Total	21	10,893	100	100	-

*Percent Stream Length calculated with only riffle, pool, culvert, and falls habitat types.
**Percent Stream Habitat calculated using all stream habitat types except tributary.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, this reach contains both not properly functioning and properly functioning characteristics. The parameter that is **at risk** is bank stability. The **properly functioning** characteristics include pool development, pool quality, sediment, LWD density and bankfull width-to-depth ratio.

Riffle habitat in Reach 1 is **properly functioning** for relative sediment content. Sediment, at 8.9% of the total average substrate, is well within the matrix standard of <20.0%.

Table 12 - Summary of habitat and substrate composition in riffle habitat of Reach 1.

Riffle Habitat Summary						
Reach	Number of Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
1	9	1091.6	24.3	1.3	2.7	
Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
1	8.9	17.8	46.7	21.1	5.6	100
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Pool habitat in Reach 1 is **properly functioning**. Pool quality is **properly functioning** as determined by residual depth. Average residual depth is 2.3 feet, above the standard. Pool development is also **properly functioning**. 38.1% of the stream habitat consists of pools, which is above the ≥30% matrix standard. The length of pool habitat relative to the other habitat types determines pool development by area of pools.

Table 138 - Summary of pool habitat and substrate percentages in Reach 1.

Pool Habitat Summary											
Reach	# Of Pools	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC	Avg. Residual Depth (ft)	# of Pools/Mile	# of Pools w/ Residual Depth ≥1'	# of Pools w/ Residual Depth ≥1'/Mile	# of Pools w/ Max. Depth ≥3'	# of Pools w/ Max. Depth ≥3'/Mile
1	8	49.9	23.8	3.7	1.4	2.3	4.2	8	4.2	7	3.7
Properly Functioning Indicators	-	-	-	-	-	≥1ft	-	-	-	-	-

Substrate Summary							
	Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
	1	11.3	13.8	36.3	13.8	25.0	100.0

Orange – Dominant Substrate

Bankfull width-to-depth ratio is **properly functioning** at 9:1, which is well within the standard of <12:1 (see Table 31).

Large woody debris is **properly functioning** with 60 pieces of large woody debris per mile, well above the standard of 30 pieces per mile.

Bank stability is **not properly functioning**, with 10.2% of the bank in Reach 1 classified as unstable (see Table 19). Most of this instability occurs in or near the Mora Campground at the confluence of the Rio Mora and the Pecos River. The instability is caused chiefly by users of the campground, particularly fishermen trampling banks to access the river. A multitude of trails in addition to the designated trail beyond the campground also adds to the instability.

Table 149 - Habitat characteristics of Reach 1.

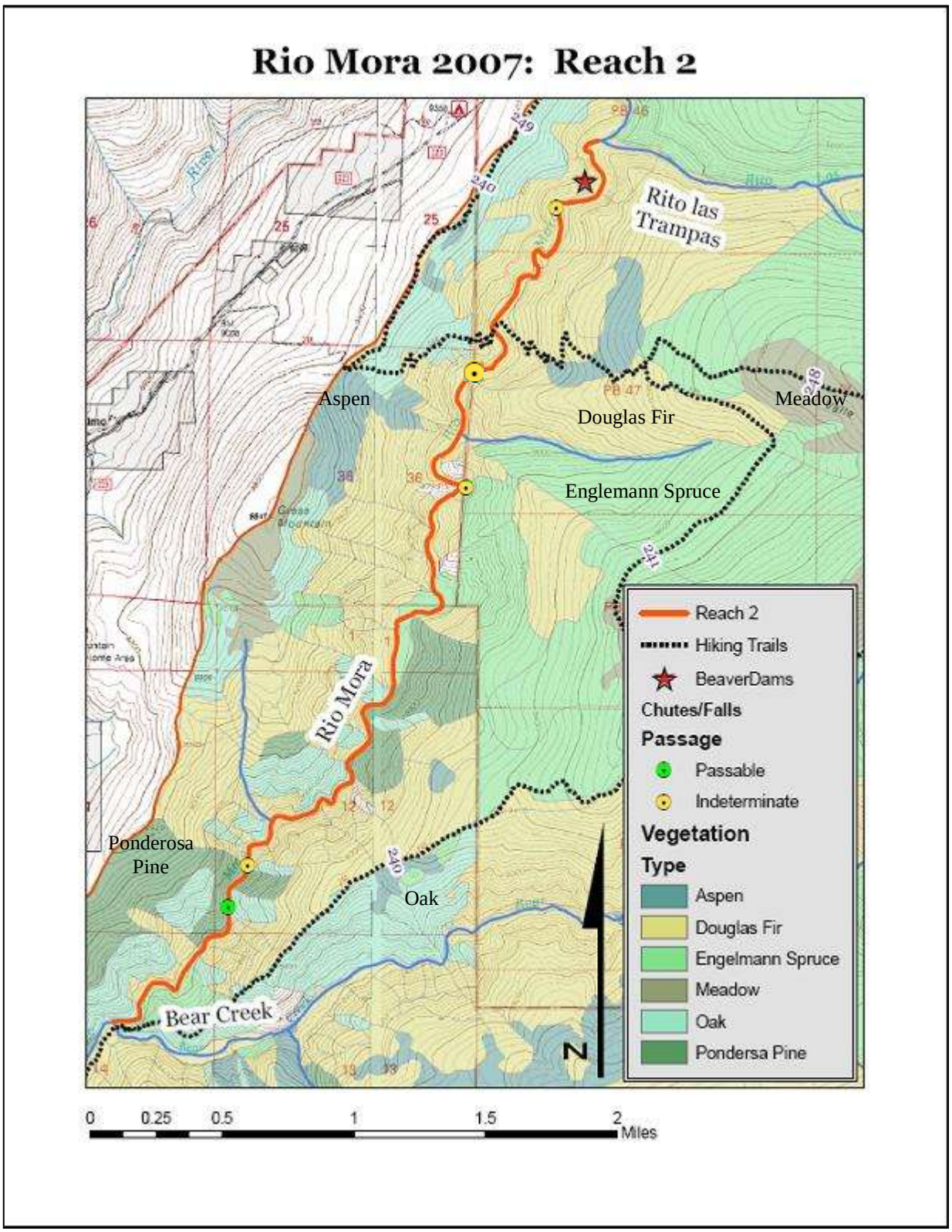
Reach	Pool:Riffle Ratio	Bankfull Width:Depth	Pieces of LWD per Mile	Total Unstable Banks (ft)	% Unstable Banks
1	1:1.1	24:1	60	2,080	10.2%
Properly Functioning Indicators	-	<12:1	>30	-	<10%

Red – Not Properly Functioning

Recommendations

Bank stability is of concern in reach one, and the impacts are concentrated in the area near the Mora campground. This campground is also a source of large amounts of litter and is the site of inadequate toilet facilities located very near the stream. More intensive management of the trail system leading up the river from this campground would benefit the river in terms of reduced sedimentation and improved riparian health. Redesign and intensive management practices in the campground could also benefit the river. Creating a riparian buffer zone separating the campground from the stream and limiting vehicle access and carrying capacity in the campground could protect the stream from bank instability and could improve riparian conditions by establishing shady fish habitat and limiting access points for recreational fishing.

REACH 2: CONFLUENCE WITH BEAR CREEK TO CONFLUENCE WITH RITO LAS TRAMPAS



Map 3 - Reach 2 Map.

Reach 2 begins at the confluence of the Rio Mora and Bear Creek. The reach extends for 4.8 miles to the confluence with Rito las Trampas where the reach was broken due to a change in the hydrologic regime. In this reach, the stream can be classified as a Rosgen type A.

Throughout Reach 2, the Rio Mora has two dominant stream types. The stream is either wide, shallow, cobbled, and sunny, or the stream is narrow, fast, and characterized by boulder and bedrock features which create tight, whitewater conditions and deep scour pools. Narrow sections of the stream often occur in high-gradient areas and have created intricate channels against cliffs and into the bedrock of the channel. In places, the stream is as deep as 3' with fast moving water constrained by a narrow slot in the bedrock. Well established riparian vegetation is present throughout the reach, and in narrow sections of the river it provides excellent shade and protection to the stream. Valley sides are steep and vegetation changes from lush riparian to semi-arid plants as one moves up these slopes. The reach ends at the Rito las Trampas, which is a tiny contributor adding less than 5% to the overall flow. The break occurs at this point because the canyon begins to change shape at this point as it approaches the meadows in Mora Flats.

Photo 16 - Bedrock chutes creating a possible barrier location.

The canyon sides remain steep throughout this reach, although near the top end of the reach the valley floor is wider. In this upper section, the river has more meanders and moves back and forth across the valley floor. Often, the river is unable to meander further because it is against cliff sides which reduce the ability of the stream to erode the outside banks of its meanders. There is still a substantial amount of sediment deposition on the inside of the curves, which narrows the channel and accelerates the stream flow. In these cases, there is often a deep channel with fast flow that creates a pool on the downstream side of the meander.

Access to reach 2 is difficult and the area is not served by any official trails. One can enter either from the trailhead near the Rio Mora campground, or can hike in on trail 242 from the Iron Gate trailhead, which intersects the river near the end of the reach. In the areas surrounding this intersection, as well as in the lower areas of the reach within a mile of the campground, user trails are present in many sections. There are also campgrounds for hike-in camping throughout, but concentrated near the two access points. No users were encountered during any of the trips into this area to survey, and although the reach barely enters the wilderness area, the stream is in pristine condition with numerous trout and beaver evident throughout.

In the upper two miles of the reach, Arizona willow is abundant along the stream channel interspersed with the more common willows present lower down in the river. The Arizona willow is not the dominant species at any point, but individual plants are present in the midst of

other riparian vegetation. Another rare plant observed to be flourishing in this reach is the Yellow Lady Slipper, a yellow orchid whose blooms diminished in brilliance during the eight days of the survey.

Large woody debris is abundant throughout the reach with increasing frequency the higher one goes in the river. Log jams are plentiful and in some sections it is possible to navigate through 30' or more of the channel without stepping off of a fallen log. While there are only a limited number of pools created by these logs that are substantial enough to be given an NSO in the survey, there are many small pools and slow eddies created by woody debris.

Photo 17 - Large tree felled by beaver.

Evidence of beaver was increasingly present in the higher sections of this reach, including a flooded meadow with multiple beaver-created structures. The presence of beaver may be responsible for much of the woody debris present lower down in the stream, and certainly they are responsible for many wood-created features near the flooded meadow. The largest felled tree was at least 18" in diameter, and it appears that the beaver have established at least 4 tiers of dams in addition to a control structure that limits the inflow to their channel. This meadow is located roughly 0.5 miles upstream from the intersection with trail 242.

There are three chutes located in this reach which vary in height from 3'-6'. All three chutes are bedrock features and create sizable obstacles – though not necessarily permanent barriers – to upstream fish migration. A snorkel reconnaissance survey was conducted of the river below, between, and above two of these chutes. The results of the survey showed a trout population comprised of brown and rainbow trout and increasingly dominated by brown trout beyond the first chute. In the pool below the lower chute there were also two large (14") suckers. These fish appear to be white suckers and were staying close to the bottom of the nearly 7' deep pool. Plentiful insects and macro-invertebrates were also observed in the stream and it appears to be excellent, high quality habitat for fish species.

Habitat Characteristics

Reach 2 is divided into 82 NSOs, measuring 5.4 miles (28,288 feet). Thirty-six (36) NSOs are pool habitats, and comprise 43.9% of the stream habitat. Thirty-seven (37) riffle habitats make up 45.1% of the stream habitat in Reach 2 (see Table 20).

Table 20 - Summary of Reach 2 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length* (%)	Stream Habitat** (%)	Properly Functioning Indicators
Pool	36	1911	7.2	44.4	>30%
Riffle	37	24,687	92.8	45.7	-
Culvert	0	0	0	0.0	-
Tributary	1	N/A	N/A	N/A	-
Falls	0	0	0	0.0	-
Side Channel	8	1690	N/A	9.9	-
Dry Channel	0	0	0	0.0	-
Total	82	28,288	100	100	-

*Percent Stream Length calculated with only riffle, pool, culvert, and falls habitat types.
**Percent Stream Habitat calculated using all stream habitat types except tributary.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 2 contains only properly functioning characteristics. The **properly functioning** characteristics include pool development, pool quality, sediment, LWD density, bank stability and bankfull width-to-depth ratio.

Riffle habitat in Reach 2 is **properly functioning** for relative sediment content. Sediment, at 5.7% of the total average substrate, is well within the matrix standard of <20.0%.

Table 21 - Summary of habitat and substrate composition in riffle habitat of Reach 2.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
2	37	667.2	19.1	1.7	3.0	
Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
2	5.7	20.3	36.5	23.2	14.3	100
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Pool habitat in Reach 2 is **properly functioning** as determined by residual depth. Average residual depth is 2.3 feet, above the standard. Pool development is also **properly functioning**. 44.4% of the stream habitat consists of pools, which is well above the ≥30% matrix standard.

Table 22 - Summary of pool habitat and substrate percentages in Reach 2.

Pool Habitat Summary											
Reach	# Of Pools	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC	Avg. Residual Depth (ft)	# of Pools/Mile	# of Pools w/ Residual Depth ≥1'	# of Pools w/ Residual Depth ≥1'/Mile	# of Pools w/ Max. Depth ≥3'	# of Pools w/ Max. Depth ≥3'/Mile
2	36	53.1	21.8	3.8	1.5	2.3	7.5	35	7.3	31	6.5
Properly Functioning Indicators	-	-	-	-	-	≥1ft	-	-	-	-	-

Substrate Summary							
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total	
2	12.2	18.1	30.3	11.9	27.5	100.0	

Orange – Dominant Substrate

Bankfull width-to-depth ratio is **properly functioning** at 9:1, which is well within the standard of <12:1 (see Table 23).

Large woody debris is **properly functioning** with 40.8 pieces of large woody debris per mile, above the standard of 30 pieces per mile (see Table 23).

Bank stability is **properly functioning**, with only 0.8% of the bank in Reach 2 classified as unstable (see Table 23).

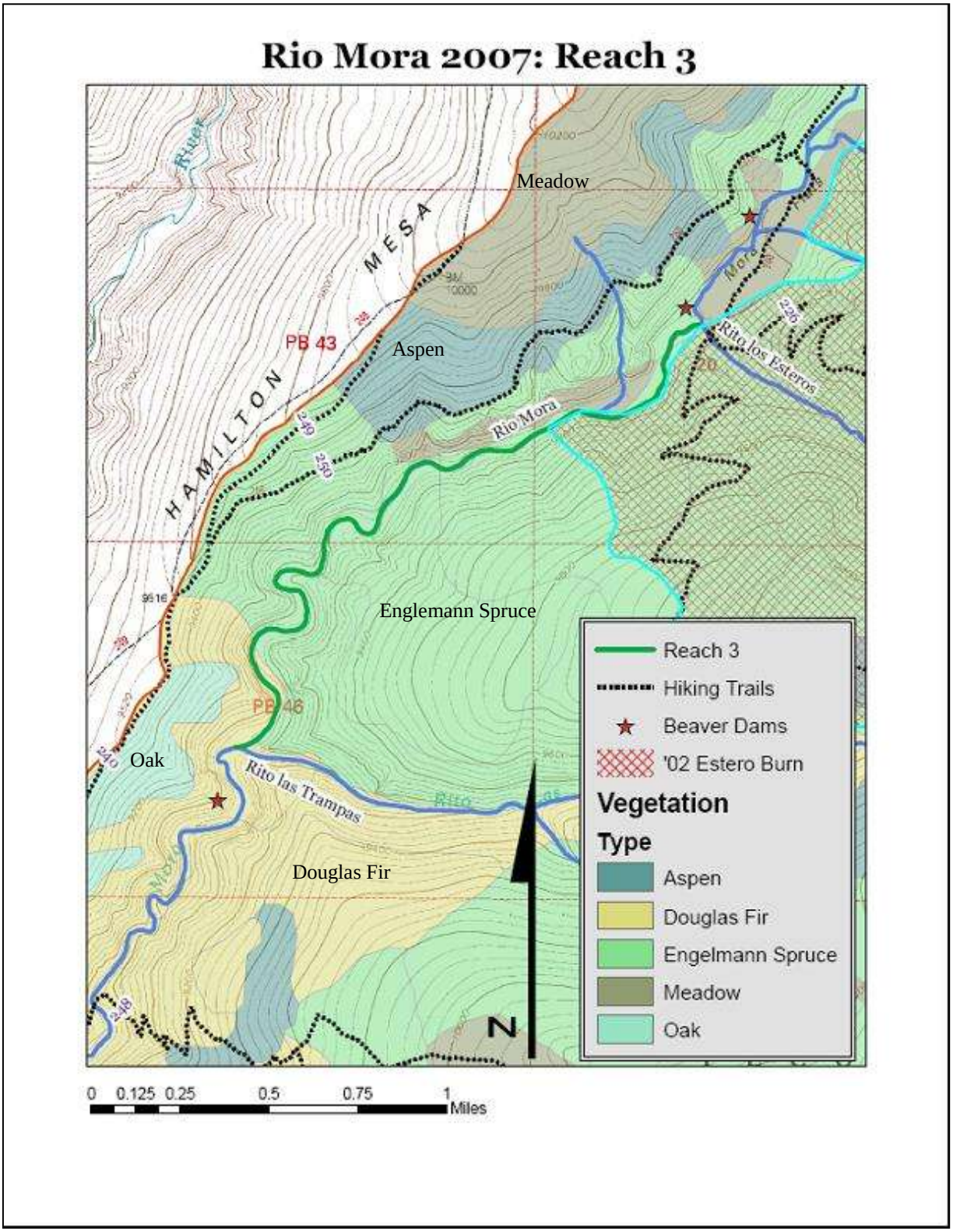
Table 15 - Habitat characteristics of Reach 2.

Reach	Pool:Riffle Ratio	Bankfull Width:Depth	Pieces of LWD per Mile	Total Unstable Banks (ft)	% Unstable Banks
2	1:1	27:1	40.8	410	0.8%
Properly Functioning Indicators	-	<12:1	>30	-	<10%

Recommendations

Reach 2 is isolated and pristine, with only one trail crossing in nearly 5 stream miles. This reach is also the site of the furthest downstream beaver habitat, a large flooded meadow with numerous beaver structures incorporating timber as large as 16" in diameter. This reach was also the site of a great deal of Arizona Willow, an endangered plant native to the southwest which is present in increasing quantities the higher one goes up the Rio Mora. This reach is in excellent condition, and could be the site of ongoing monitoring of beaver habitat to evaluate the impacts of beaver on vegetative diversity, recovery, and the benefits of beaver to the condition of natural streams.

REACH 3: CONFLUENCE WITH RITO LAS TRAMPAS TO CONFLUENCE WITH RITO LOS ESTEROS



Map 4 - Reach 3 Map.

Reach 3 begins at the confluence of the Rio Mora and the Rito las Trampas. The reach extends for 2.4 miles to the confluence of the Rio Mora and the Rito los Esteros, which occurs immediately downstream from Mora flats. The reach was ended at this point due to a change in valley morphology and hydrologic regime. In this reach, the stream can be classified as a Rosgen type A, with sections that could be considered B types. This reach of the stream is extremely scenic with tremendous aesthetic value and little human use.

Photo 18 - One of many log jams creating pools in Reach 3.

Like the first 2 reaches of the river, Reach 3 has two dominant stream types. The stream is either wide, shallow, and cobbled, or the stream is narrow, fast, and characterized by boulder and bedrock features. Of these two modes, most of the reach is wider and shallower more often than narrow and deep. Unlike the previous reaches, Reach 3 had huge amounts of wood in the stream – generally large spruce whose source was clearly the nearby shore. While there is well-established riparian vegetation throughout the reach, there is also a preponderance of snags and dead wood. This dead wood, in combination with the contributions of beaver, has created numerous log jams, and is the primary cause of pools throughout the reach. Valley sides are steep, and in many places sheer cliffs confine the stream or loom nearby. A recent fire around the Rito los Esteros left many burned trees which are increasingly prevalent towards the end of the reach. The Rito los Esteros is a high-gradient series of small pools separated by large boulders and contributes an estimated 15% to the total flow of the Rio Mora at that point.

The canyon walls remain steep in this reach, but the valley floor widens throughout the reach to eventually open into a large meadow – the Mora Flats – just upstream from the Rito los Esteros. Most of the features – large pools, small pools, and small falls – are the product of woody debris in the stream. In one riffle, more than 50 pieces of Large Woody Debris were encountered. One impact of these logs is that they substantially slow the flow above them which catches substantial quantities of sediment and greater concentrations of sandy substrate than have been encountered previously. Stick- and Log-Jams throughout the reach have pieces of wood that show evidence of having been chewed on by beaver.

Access to reach 3 is difficult as there are no official trails – and for the most part no unofficial trails – along the stream. Access is available either by hiking from the Iron Gate trailhead through the Mora Flats, or by hiking down trail 242 and working upstream. No campsites, campers, or hikers were encountered during the survey of this reach. The stream is in pristine condition throughout this reach and showed extensive evidence of beaver in addition to numerous trout.

Throughout reach 3, Arizona willow is abundant along the stream channel interspersed with the more common willows. The Arizona willow is not the dominant species at any point, but

individual plants are present in the midst of other riparian vegetation. Riparian vegetation throughout the reach is well established and provides a good mix of sun and shade on the stream.

Habitat Characteristics

Reach 3 is divided into 33 NSOs, measuring 2.5 miles (13,140 feet). Fifteen (15) NSOs are pool habitats, and comprise 46.9% of the stream habitat. Fifteen (15) riffle habitats make up 46.9% of the stream habitat in Reach 3 (see Table 24).

Table 164 - Summary of Reach 3 habitat types

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length* (%)	Stream Habitat** (%)	Properly Functioning Indicators
Pool	15	786	6.1	46.9	>30%
Riffle	15	12,164	93.9	46.9	-
Culvert	0	0	0.0	0.0	-
Tributary	1	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	2	190	N/A	6.3	-
Dry Channel	0	0	0.0	0.0	-
Total	33	13,140	100	100.0	-

*Percent Stream Length calculated with only riffle, pool, culvert, and falls habitat types.
**Percent Stream Habitat calculated using all stream habitat types except tributary.

When compared to the matrix of factors and indicators of stream condition for historic and occupied RGCT streams, Reach 2 contains only properly functioning characteristics. The **properly functioning** characteristics include pool development, pool quality, sediment, LWD density, bank stability and bankfull width-to-depth ratio.

Riffle habitat in Reach 3 is **properly functioning** for relative sediment content. Sediment, at 10.0% of the total average substrate, is within the matrix standard of <20.0%.

Table 25 - Summary of habitat and substrate composition in riffle habitat of Reach 3.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
3	15	810.9	21.4	1.2	2.3	
Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
3	10.0	17.3	44.0	22.7	6.0	100
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Pool habitat in Reach 3 is **properly functioning** as determined by residual depth. Average residual depth is 1.9 feet, above the standard. Fourteen of the 15 pools in Reach 3 had a residual depth greater than 1', and 10 of the 15 had a residual depth of at least 3' (see Table 26). Pool development is also **properly functioning** with 46.9% of the stream habitat consisting of pools, which is well above the ≥30% matrix standard.

Table 17 - Summary of pool habitat and substrate percentages in Reach 3.

Pool Habitat Summary											
Reach	# Of Pools	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC	Avg. Residual Depth (ft)	# of Pools/Mile	# of Pools w/ Residual Depth ≥1'	# of Pools w/ Residual Depth ≥1'/Mile	# of Pools w/ Max. Depth ≥3'	# of Pools w/ Max. Depth ≥3'/Mile
3	15	52.4	22.3	3.1	1.1	1.9	6.3	14	5.8	10	4.2
Properly Functioning Indicators	-	-	-	-	-	≥1ft	-	-	-	-	-

Substrate Summary							
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total	
3	29.3	13.3	26.7	15.3	15.3	100.0	

Orange – Dominant Substrate

Bankfull width-to-depth ratio is **properly functioning** at 9:1, which is well within the standard of <12:1 (see Table 27).

Large woody debris is **properly functioning** with 109.2 pieces of large woody debris per mile, is exceedingly above the standard of 30 pieces per mile.

Bank stability is **properly functioning**, with only 1.1% of the bank in Reach 2 classified as unstable (see Table 27).

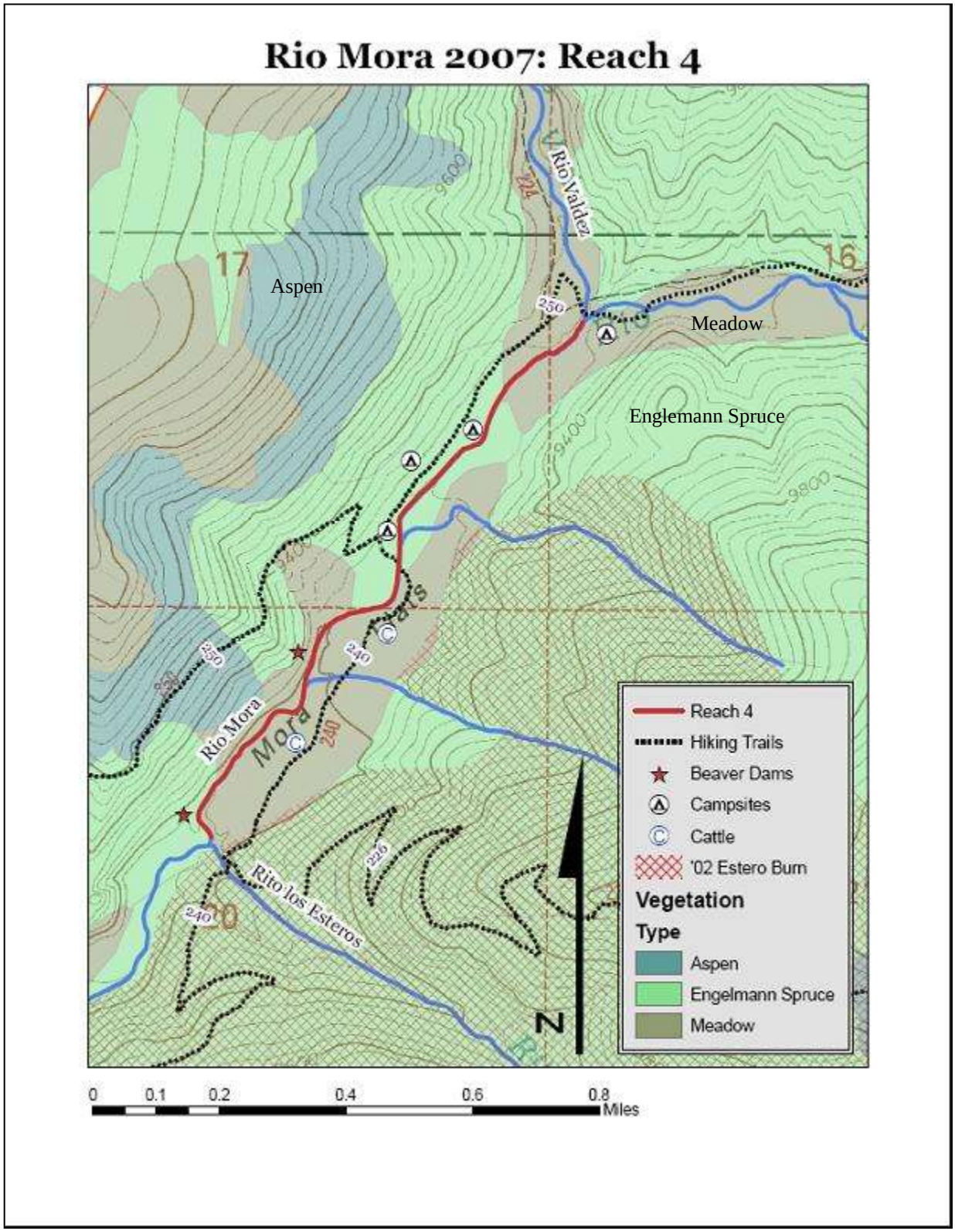
Table 27 - Habitat characteristics of Reach 3.

Reach	Pool:Riffle Ratio	Bankfull Width:Depth	Pieces of LWD per Mile	Total Unstable Banks (ft)	% Unstable Banks
3	1:1	17:1	109.2	280	1.1%
Properly Functioning Indicators	-	<12:1	>30	-	<10%

Recommendations

This reach ends at the Rito los Esteros, a tributary with an identified population of RGCT. As such, efforts to restore RGCT in their historic range should seek to locate a fish barrier in this reach, if not an earlier one, in order to link existing RGCT populations. The stream is the site of excellent fish habitat due in large part to a preponderance of woody debris throughout.

REACH 4: CONFLUENCE WITH RITO LOS ESTEROS TO CONFLUENCE WITH RIO VALDEZ



Map 5 - Reach 4 Map.

Reach 4 begins at the confluence of the Rio Mora and the Rito los Esteros. The reach extends for 1.1 miles to the confluence of the Rio Mora and the Rio Valdez. The reach ends at the braided confluence of the two rivers which extends for nearly 500' downstream from the abrupt end to the hillside segregating the two meadows of each river above the confluence. The reach break signifies both a change in river hydrology by the significant input from the Rio Valdez, estimated at 25%, as well as for morphological reasons as the valley of the Mora Flats narrows to become more restrictive with less expansive meadows which are not currently grazed. Nearly the entire reach is most aptly described as a Rosgen Stream-type B. This reach of the stream is extremely scenic with tremendous aesthetic value and little human use.

Photo 19 - Pooled water above a beaver dam.

Like the other reaches of the river, Reach 4 has two dominant stream types. The stream is either wide, shallow, and cobbled, or the stream is narrow, fast, and characterized by boulder and bedrock features. Of these two modes, the majority of the stream is composed of shallow cobbled runs. The reach is overall shallow, with only a small number of pools separating long riffles. Along the right bank there are a great deal of side channels, most of which were dry by the time of the survey. These channels extend outward into the meadows of the Mora Flats for over a hundred yards in places, and create a series of raised cobble bars, wet meadows, and stagnant pools. The channels are decreasingly vegetated the further from the stream they are situated, with the nearest having fully forested banks and the furthest with only marginal willow cover. During wet periods these channels surely flow, providing a large amount of additional habitat for fish which then gradually dries and recedes throughout the summer.

The majority of large wood in the reach was in either an old beaver dam towards the beginning of the reach or else in a number of small wood jams and fishing weirs. The burn that surrounded the Rito los Esteros quickly fades away in the beginning of the reach and largely does not affect the stream. Though nearly the entire reach retains at least a riparian tree buffer when not surrounded by mature spruce forest, there are relatively few standing dead trees as compared to earlier reaches, and an overall reduction of dead wood in general.

Photo 20 - Estero burn from the Mora flats.

The valley walls are much more gradual than Reach 3, and the entire valley opens

to a broad, flat bottom. The meadows of the Mora Flat extend over much of the valley floor, with a spruce forest buffer between the meadows and the stream. The meadows are largely a complex of wet meadow intersected by channels that give way to grassy mounds that extend to the far (Eastern) valley wall. Shrubby cinquefoil (*Potentilla fruticosa)* is abundant in the actually meadow, and is practically the only herbaceous plant in the meadows, which are grazed by cattle.

Photo 21 - Fishing weir near campsites.

Access to Reach 4 is facilitated by trails, especially trail 250 originating from the Iron Gate Campground about 2-3 miles up trail, which intersects with trail 240 which travels south toward the Rito los Esteros and trail 226. The easy access to the backcountry in the Mora Flats translates to a high level of use from both hikers and packers. Along the left bank are numerous campsites, fire rings, and trails which are evident along nearly the entire length of the reach. Above the trail crossing of the stream fisherman trails increasing affect the stream banks, with frequent stretches of the banks 20'-30' long showing denuded vegetation, unstable and collapsing banks. Human impact only begins to lighten toward the very end of the reach, near the confluence with the Rio Valdez, and even then there are large campsites on the right bank with obvious stream crossings.

Cattle grazing does take place on the Rio Mora and during a previous survey earlier in the season focused on the Mora Flats about 30 cows were seen in the meadows. Evidence of cows appeared to be heaviest on the channel furthest from the stream that was still wet. However, cow damage was in no place ever considered to be extensive, and only at one distinct stretch was there evidence of collapsing or unstable banks along the Mora itself because of cattle. Stream and riparian damage from human use was by far more severe and extensive than that caused by cattle.

Photo 22 - Campsite along left bank.

Throughout Reach 4, Arizona Willow is abundant along the stream channel interspersed with the more common willows. The Arizona willow is not the dominant species at any point, but individual plants are present in the midst of other riparian vegetation. Riparian vegetation throughout the reach is well established and provides a good mix of sun and shade on the stream.

Habitat Characteristics

Reach 4 is divided into 12 NSOs, measuring 1.2 miles (6,417 feet). Three (3) NSOs are pool habitats, and comprise 27.3% of the stream habitat. Four (4) riffle habitats make up 36.4% of the stream habitat in Reach 4 (see Table 28).

Table 18 - Summary of Reach 4 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length* (%)	Stream Habitat** (%)	Properly Functioning Indicators
Pool	3	132	2.2	27.3	>30%
Riffle	4	5984	97.8	36.4	-
Culvert	0	0	0.0	0.0	-
Tributary	1	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	4	301	N/A	36.4	-
Dry Channel	0	0	0.0	0.0	-
Total	12	6417	100	100	-

Red – Not Properly Functioning
*Percent Stream Length calculated with only riffle, pool, culvert, and falls habitat types.
**Percent Stream Habitat calculated using all stream habitat types except tributary.

Table 199 - Summary of habitat and substrate composition in riffle habitat of Reach 4.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
4	4	1496.0	16.0	1.2	2.5	
Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
4	0	20	60	20	0	100
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Table 30 - Summary of pool habitat and substrate percentages in Reach 4.

Pool Habitat Summary											
Reach	# Of Pools	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC	Avg. Residual Depth (ft)	# of Pools/Mile	# of Pools w/ Residual Depth ≥1'	# of Pools w/ Residual Depth ≥1'/Mile	# of Pools w/ Max. Depth ≥3'	# of Pools w/ Max. Depth ≥3'/Mile
4	3	44.0	16.3	2.7	1.1	1.6	2.7	2	1.8	1	0.9
Properly Functioning Indicators	-	-	-	-	-	≥1ft	-	-	-	-	-

Substrate Summary							
	Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
	4	6.7	20.0	63.3	10.0	0.0	100.0

Orange – Dominant Substrate

Table 31 - Habitat characteristics of Reach 4.

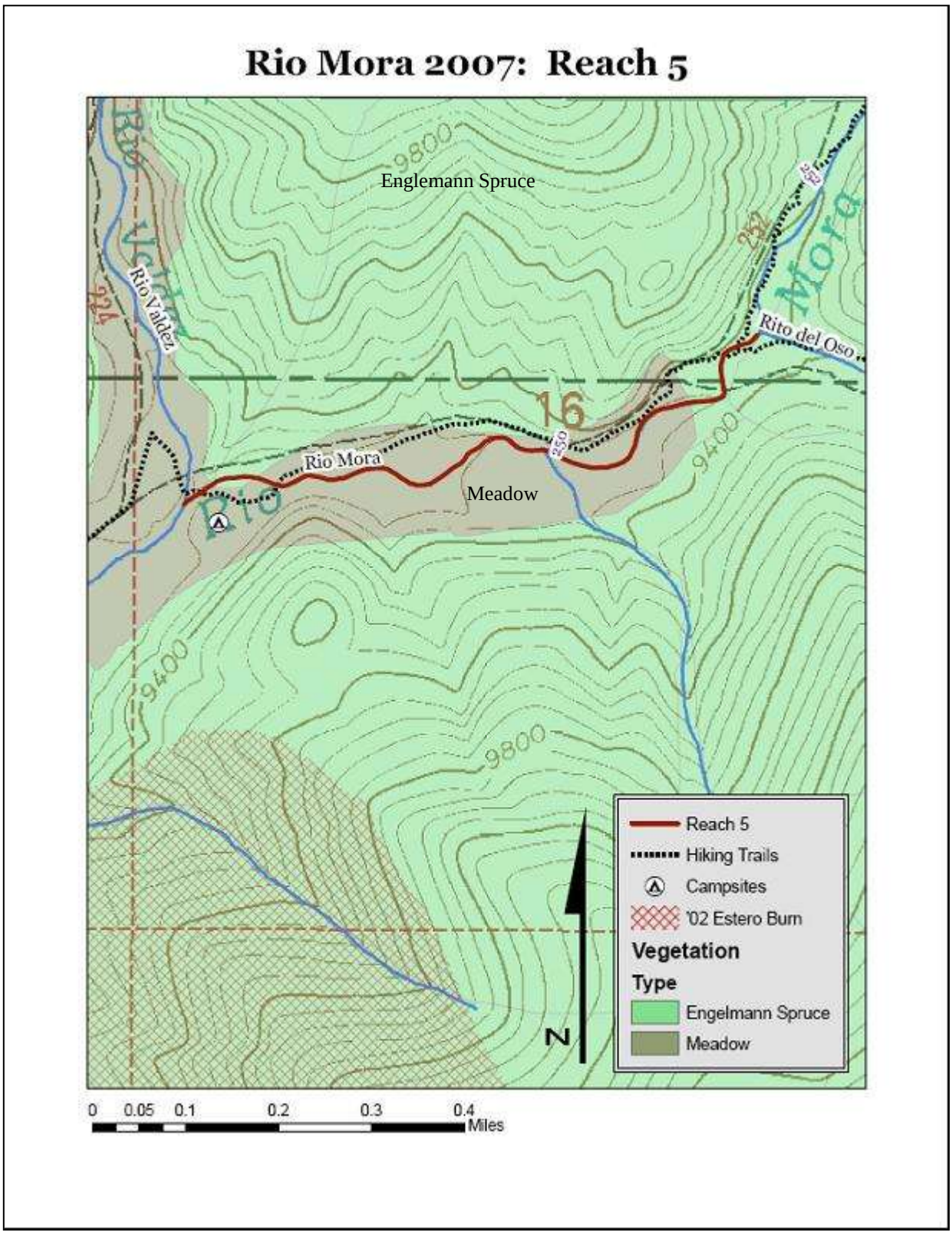
Reach	Pool:Riffle Ratio	Bankfull Width:Depth	Pieces of LWD per Mile	Total Unstable Banks (ft)	% Unstable Banks
4	1:1.3	11.4:1	14.5	1,500	12.3%
Properly Functioning Indicators	-	<12:1	>30	-	<10%

Red – Not Properly Functioning

Recommendations

This reach runs through the Mora flats, an area actively used for cattle and for recreational camping and angling. Bank stability and vegetation diversity are both reduced in this area, including one area in particular in which a meander in the river has created an exposed section of unstable banks several feet deep (see photo 6). Limiting grazing in this area during times of high vegetative productivity could improve riparian areas could help to re-establish willows and riparian vegetation along the stream. Near the top of the reach, campsites line the stream along the left bank and user-created fish weirs are present in the stream itself. This area appears to be heavily used and could benefit from lighter use, which could be facilitated by creating additional sites nearby to offset the impact of campers in the riparian area.

REACH 5: CONFLUENCE WITH RIO VALDEZ TO CONFLUENCE WITH RITO DEL OSO



Map 6 - Reach 5 Map.

Reach 5 begins at the confluence of the Rio Mora and the Rio Valdez, which come together at the upper end of the Mora Flats. This reach extends for 0.7 miles to the confluence of the Rio Mora with the Rito del Oso at which point the reach was broken due to a change in hydraulic regime – the Rito del Oso contributes an estimated 20% to the total flow at that point. Throughout this reach, the Rio Mora can be characterized as B channel.

Photo 23 - Narrow stream through thick riparian vegetation.

In this reach, the stream is substantially narrower – due to reduced flows – from further downstream. Nonetheless, like other reaches of the river, Reach 5 has two dominant stream types. The stream is either wide, shallow, and cobbled, or the stream is narrow, fast, and characterized by boulder and bedrock features. In this reach, the stream is long riffles punctuated by small, shallow scour pools created by small falls over boulders with cobble- or small-boulder tailcrest controls. Numerous ephemeral side channels are present, which suggests that at high flows the stream finds its way into small side channels rather than widening into a distinct floodplain.

Riparian vegetation throughout the reach is substantial and thick. Alders and willows crowd the banks and from the stream, it is only possible to catch occasional glimpses of the meadow on the left bank. On either side of the river, the valley floor is relatively flat – particularly on the left bank, which has a substantial meadow. While there are numerous snags and fallen trees on the sides, few of these have ended up in the river as they did in more constricted sections of the valley.

Algae was more prevalent in this reach than it has been in previous ones and grows to substantial length – up to 6 inches – giving rocky pools a hairy look. The valley floor through this reach is distinctly separate from the Mora flats and does not show evidence of continued camper- and cow-presence.

Photo 24 - Trail 252 above the confluence with the Rio Valdez.

Reach 5 is accessed by trail 250 from the Iron Gate trailhead, which diverts and begins climbing Bordo del Medio soon after reach 5 ends. Despite the ease of access, the trail seems to be used with less frequency than the earlier sections of the 250 trail or than the trail which follows the Rio Valdez. Numerous side trails – presumably created by fisherman moving upstream from the flats – are present throughout the reach.

Throughout Reach 5, Arizona Willow is present along the stream channel interspersed with the more common willows. The Arizona willow is not the dominant species at any point, but individual plants are present in the midst of other riparian vegetation. Riparian vegetation throughout the reach is well established and provides a good mix of sun and shade on the stream.

Habitat Characteristics

Reach 5 is divided into 12 NSOs, measuring 3/4 miles (3,944 feet). Four (4) NSOs are pool habitats, and comprise 36.4% of the stream habitat. Five (5) riffle habitats make up 45.5% of the stream habitat in Reach 5 (see Table 32).

Table 202 - Summary of Reach 5 habitat types

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length* (%)	Stream Habitat** (%)	Properly Functioning Indicators
Pool	4	122	3.4	36.4	>30%
Riffle	5	3452	96.6	45.5	-
Culvert	0	0	0.0	0.0	-
Tributary	1	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	2	370	N/A	18.2	-
Dry Channel	0	0	0.0	0.0	-
Total	12	3944	100	100	-

*Percent Stream Length calculated with only riffle, pool, culvert, and falls habitat types.
**Percent Stream Habitat calculated using all stream habitat types except tributary.

Table 33 - Summary of habitat and substrate composition in riffle habitat of Reach 5.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
5	5	690.4	14.4	.9	1.9	
Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
5	10.0	20.0	44.0	26.0	0.0	100
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Table 214 - Summary of pool habitat and substrate percentages in Reach 5.

Pool Habitat Summary											
Reach	# Of Pools	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC	Avg. Residual Depth (ft)	# of Pools/Mile	# of Pools w/ Residual Depth ≥1'	# of Pools w/ Residual Depth ≥1'/Mile	# of Pools w/ Max. Depth ≥3'	# of Pools w/ Max. Depth ≥3'/Mile
5	4	30.5	13.5	2.1	1.1	1.0	5.7	2	2.9	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1ft	-	-	-	-	-

Substrate Summary							
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total	
5	20.0	20.0	57.5	2.5	0.0	100.0	

Orange – Dominant Substrate

Table 35 - Habitat characteristics of Reach 5.

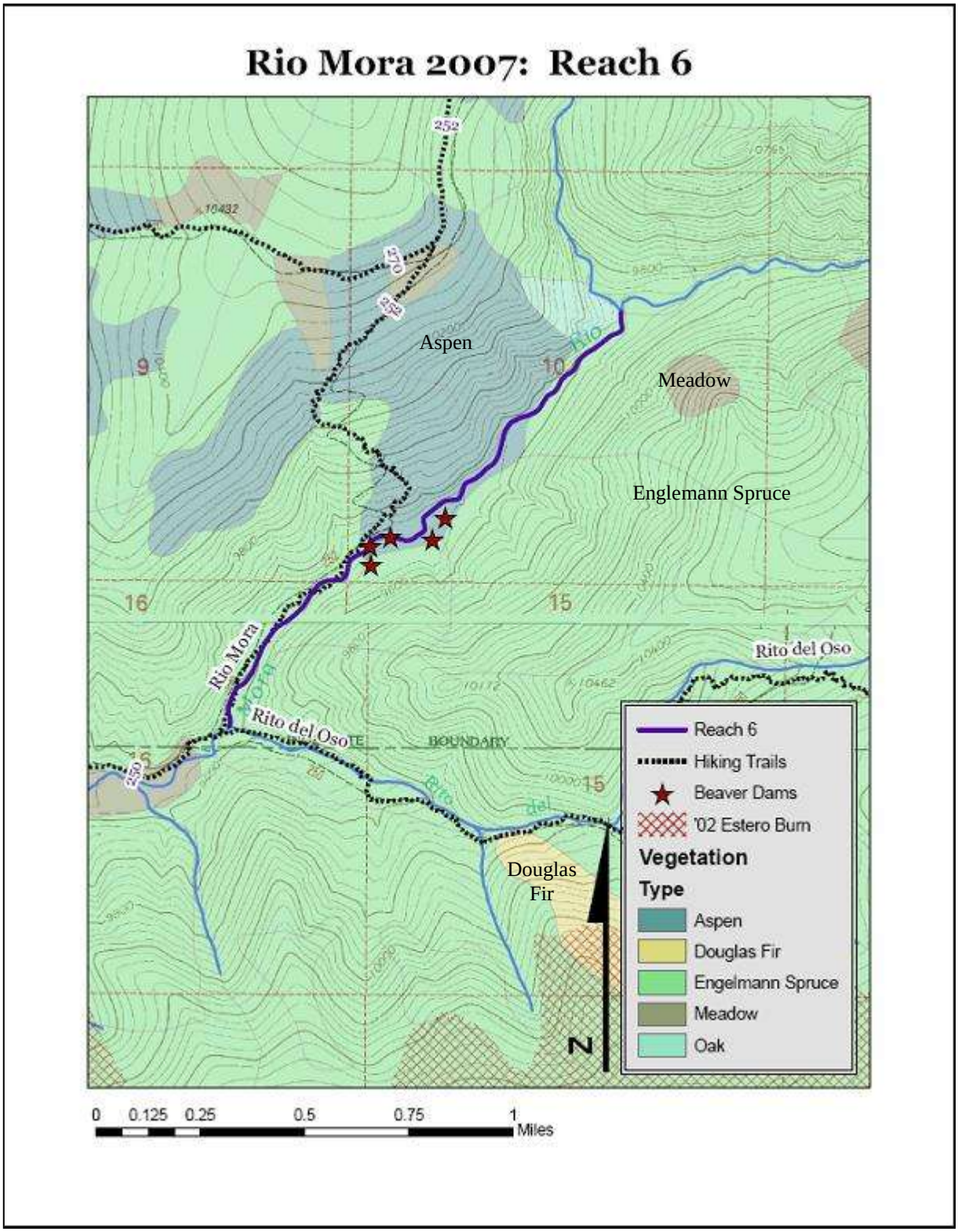
Reach	Pool:Riffle Ratio	Bankfull Width:Depth	Pieces of LWD per Mile	Total Unstable Banks (ft)	% Unstable Banks
5	1:1.3	11.2:1	8.6	313	4.4%
Properly Functioning Indicators	-	<12:1	>30	-	<10%

Red – Not Properly Functioning

Recommendations

This reach is in excellent condition, which is facilitated by the fact that the majority of the recreational users continue upstream along the Valdez rather than the Mora. Trails along the Mora in this area are lightly maintained, and trail signs are the best clue to locating these trails. The river through this section is in excellent condition, and was a productive site for weekend fishing.

REACH 6: CONFLUENCE OF RITO DEL OSO TO CONFLUENCE WITH SIGNIFICANT LB UNNAMED TRIBUTARY



Map 7 - Reach 6 Map.

Reach 6 begins at the confluence of the Rito del Oso and the Rio Mora. The reach extends for 1.5 miles, at which point the reach meet an unnamed contributor stream which enters on the left bank. The reach was broken at this point due to changes in hydraulic regime and stream channel morphology. In this reach the stream can be classified as a Rosgen type B stream, with sections of A channel.

Photo 25 - Arizona willow leaves.

In this reach, the stream is dramatically narrower than it has been in previous sections. The channel is still primarily shallow and cobbles, but the cobbles are larger and less uniformly round, also there are more numerous boulders. In places the riparian vegetation is so thick that willow and alder reach across the entire width of the channel. The valley remains wide enough to support a meadow on the right bank for most of the reach, and a substantial network of beaver dams and ponds on the left. Vegetation in the riparian area is somewhat less thick, although the plants that are there seem to be well established and permanent. Sub-Alpine fir species become dominant during this reach. The thick, "hairy" looking algae that we had recently begun to see seems to be less prominent on the cobbles in the pools.

This reach contains the most extensive beaver pond and dam system so far along the river.

Photo 26 - Off-Stream beaver pond.

Along the right bank of the river, for a distance of nearly a quarter mile, a series of at least five large beaver ponds – each at least a quarter acre in area – are well established. These ponds create a wetland throughout the area, with 2-8" of standing water throughout the grass. The ponds were held in by dams ranging from 18" – 4' in height and 100' in length. The pools were sandy-bottomed, and the sand was deep and soft. Beaver lodges were prominent in three of the pools, although 2 of the lodges appear to be more actively used than the third. The upper ponds seem to be well established based on the amount of grass and foliage that has grown on the sides of the dam itself. On our way back down at the end of the day, there was a duck with several ducklings paddling across the upper pond.

Exciting historical note: While speaking with one of the campground hosts about the beaver ponds we had seen, he told us that he had read a book called Beatty's Cabin in which the author (Beatty?) claimed that the beavers had all been extinct in the lower sections of the river and were re-established by a single pair of beaver that moved down from Pecos Baldy lake into the upper Pecos and Mora rivers.

Reach 6 is accessed from the Iron Gate campground by hiking in to the Mora Flats and then continuing up the Mora on the Rociada trail. The trail is not well maintained, but leads more or less along the left bank of the river for most of the reach.

Photo 27 - Tall secton of a large beaver dam.

Habitat Characteristics

Reach 6 is divided into 24 NSOs, measuring 1.6 miles (8,520 feet). Ten (10) NSOs are pool habitats, and comprise 43.5% of the stream habitat. Eleven (11) riffle habitats make up 47.8% of the stream habitat in Reach 6 (see Table 36).

Table 226 - Summary of Reach 6 habitat types

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length* (%)	Stream Habitat** (%)	Properly Functioning Indicators
Pool	10	484	6.0	43.5	>30%
Riffle	11	7601	94.0	47.8	-
Culvert	0	0	0.0	0.0	-
Tributary	1	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	2	435	N/A	8.7	-
Dry Channel	0	0	0.0	0.0	-
Total	24	8520	100	100	-

*Percent Stream Length calculated with only riffle, pool, culvert, and falls habitat types.
**Percent Stream Habitat calculated using all stream habitat types except tributary.

Table 237 - Summary of habitat and substrate composition in riffle habitat of Reach 6.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
6	11	691.0	14.6	1.4	2.4	
Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
6	0.9	20.9	49.1	27.3	1.8	100
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Table 248 - Summary of pool habitat and substrate percentages in Reach 6.

Pool Habitat Summary											
Reach	# Of Pools	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC	Avg. Residual Depth (ft)	# of Pools/Mile	# of Pools w/ Residual Depth ≥1'	# of Pools w/ Residual Depth ≥1'/Mile	# of Pools w/ Max. Depth ≥3'	# of Pools w/ Max. Depth ≥3'/Mile
6	10	25.5	26.1	2.7	1.1	1.6	6.7	9	6.0	3	2.0
Properly Functioning Indicators	-	-	-	-	-	≥1ft	-	-	-	-	-

Substrate Summary							
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total	
6	14.0	22.0	38.0	21.0	5.0	100.0	

Orange – Dominant Substrate

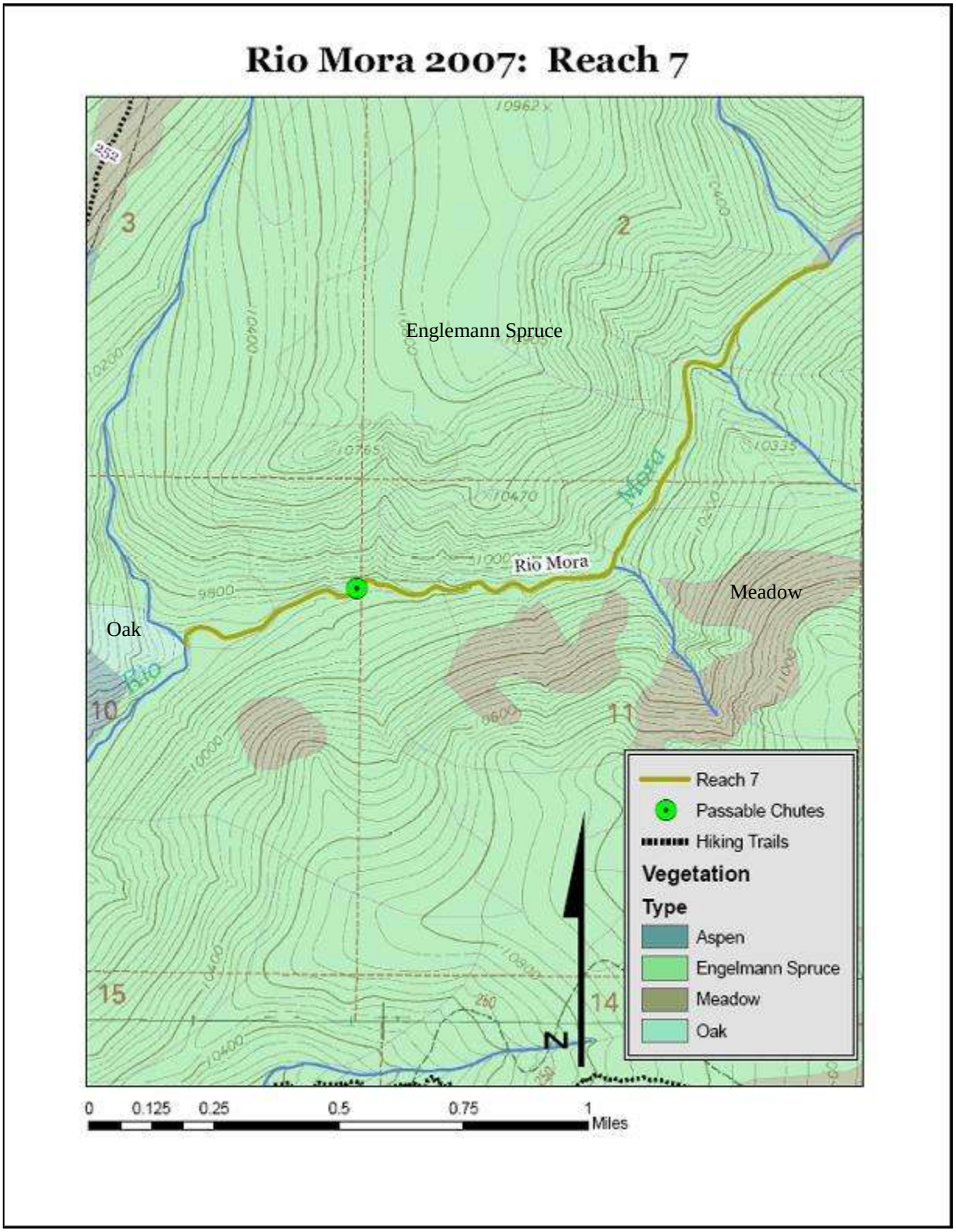
Table 259 - Habitat characteristics of Reach 6.

Reach	Pool:Riffle Ratio	Bankfull Width:Depth	Pieces of LWD per Mile	Total Unstable Banks (ft)	% Unstable Banks
6	1:1.1	14.9:1	37.3	80	0.5%
Properly Functioning Indicators	-	<12:1	>30	-	<10%

Recommendations

This reach is in pristine condition and contained the second, and most extensive, area of beaver habitat. The series of beaver ponds in this reach are its most unique asset, and the conservation of this site should be a management priority in this reach. Monitoring of beaver migration in this area as well as the condition of surrounding meadows would provide an excellent opportunity to examine the effects of beaver on high mountain streams in this state.

REACH 7: CONFLUENCE WITH SIGNIFICANT LB UNNAMED CONTRIBUTOR TO CONFLUENCE WITH SECOND SIGNIFICANT LB UNNAMED CONTRIBUTOR



Map 8 - Reach 7 Map.

Reach 7 begins at the confluence of the Rio Mora with a significant unnamed tributary that enters the stream on the left bank from the north. The reach extends for 1.9 miles, at which point the reach is broken due to a change in hydraulic regime – the Rio Mora is joined by a second significant unnamed tributary that enters on the left bank from the north. The majority of this reach can be characterized as a B channel, although a section of this stream reach can be classified as an Aa+ channel.

Photo 28 - Rock cliffs channelizing the river.

Access to this reach is difficult and there are no official trials into the area. Access is possible by traveling directly up the Rio Mora, which has some informal trails along its banks, by dropping in without a trail from the skyline and Bordo del Medio trails on either ridge, or by moving downstream for several miles from the uppermost headwaters of the river.

The tenth riffle of this reach is 364 feet long and is the section of the channel that could be classified as an Aa+ channel. In this riffle, the stream rises through a series of falls and pools created by large boulders and a very high stream gradient. During our survey, we felt that this was likely the location of a fish passage barrier, which likely marks the downstream end of RGCT habitat. Subsequent surveys revealed that this is not the case as brown trout were found inhabiting the stream above this chute.

In this reach, the stream is dominated by shallow gradient meadow sections – most of which possessed abundant willows on the stream-banks and covering the narrow channel. These shallow-gradient sections were punctuated by boulder-strewn, high gradient reaches. The valley had abundant talus fields, and these seemed to be the source of the boulders in these areas. The average width of the channel for this reach was around 10', which is substantially narrower than the 12' average width in the .5 miles immediately downstream from this reach.

Photo 29 - Boulders and LWD in stream.

Throughout this survey, and in the preceding weeks, it was common for there to be a few hours of rain each afternoon, and for most of the day to be overcast. One result of this was that the area was very wet during the survey, which made it difficult to distinguish between ephemeral and permanent tributaries. Certainly,

as we reached higher into the watershed, the rate at which small channels joined the Mora increased significantly. However, none of these tributaries supported adequate depth to support fish, with most being only a few inches wide and less than 3" deep.

The predominant features of this reach were the preponderance of willow and alder, which entirely covered the stream in some areas for as much as 200' at a time, and the introduction of frequently occurring high gradient chutes and boulder features. Some of the plants were Arizona willow, although this species seems to be interspersed throughout the area rater than dominating in any particular part of the reach. Through we initially believed that the high-gradient boulder-chutes part way into the reach were a barrier to upstream fish migration, subsequent surveys showed brown trout to be dominant above this section, in which case they are surely present throughout the reach as there are no other barrier features.

Habitat Characteristics

Reach 7 is divided into 61 NSOs, measuring 2.1 miles (11,257 feet). Twenty-seven (27) NSOs are pool habitats, and comprise 45.0% of the stream habitat. Twenty-eight (28) riffle habitats make up 46.7% of the stream habitat in Reach 7 (see Table 40).

Table 40 - Summary of Reach 7 habitat types

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length* (%)	Stream Habitat** (%)	Properly Functioning Indicators
Pool	27	831	7.8	45.0	>30%
Riffle	28	9821	92.2	46.7	-
Culvert	0	0	0.0	0.0	-
Tributary	1	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	5	605	N/A	8.3	-
Dry Channel	0	0	0.0	0.0	-
Total	61	11257	100	100	-

*Percent Stream Length calculated with only riffle, pool, culvert, and falls habitat types.
**Percent Stream Habitat calculated using all stream habitat types except tributary.

Table 261 - Summary of habitat and substrate composition in riffle habitat of Reach 7.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
7	28	350.8	11.4	1.3	2.1	
Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
7	2.1	20.4	48.9	26.1	2.5	100
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Table 272 - Summary of pool habitat and substrate percentages in Reach 7.

Pool Habitat Summary											
Reach	# Of Pools	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC	Avg. Residual Depth (ft)	# of Pools/Mile	# of Pools w/ Residual Depth ≥1'	# of Pools w/ Residual Depth ≥1'/Mile	# of Pools w/ Max. Depth ≥3'	# of Pools w/ Max. Depth ≥3'/Mile
7	27	30.8	12.4	2.6	1	1.7	14.2	24	12.6	8	4.2
Properly Functioning Indicators	-	-	-	-	-	≥1ft	-	-	-	-	-

Substrate Summary							
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total	
7	7.0	23.0	45.6	24.1	0.4	100.0	

Orange – Dominant Substrate

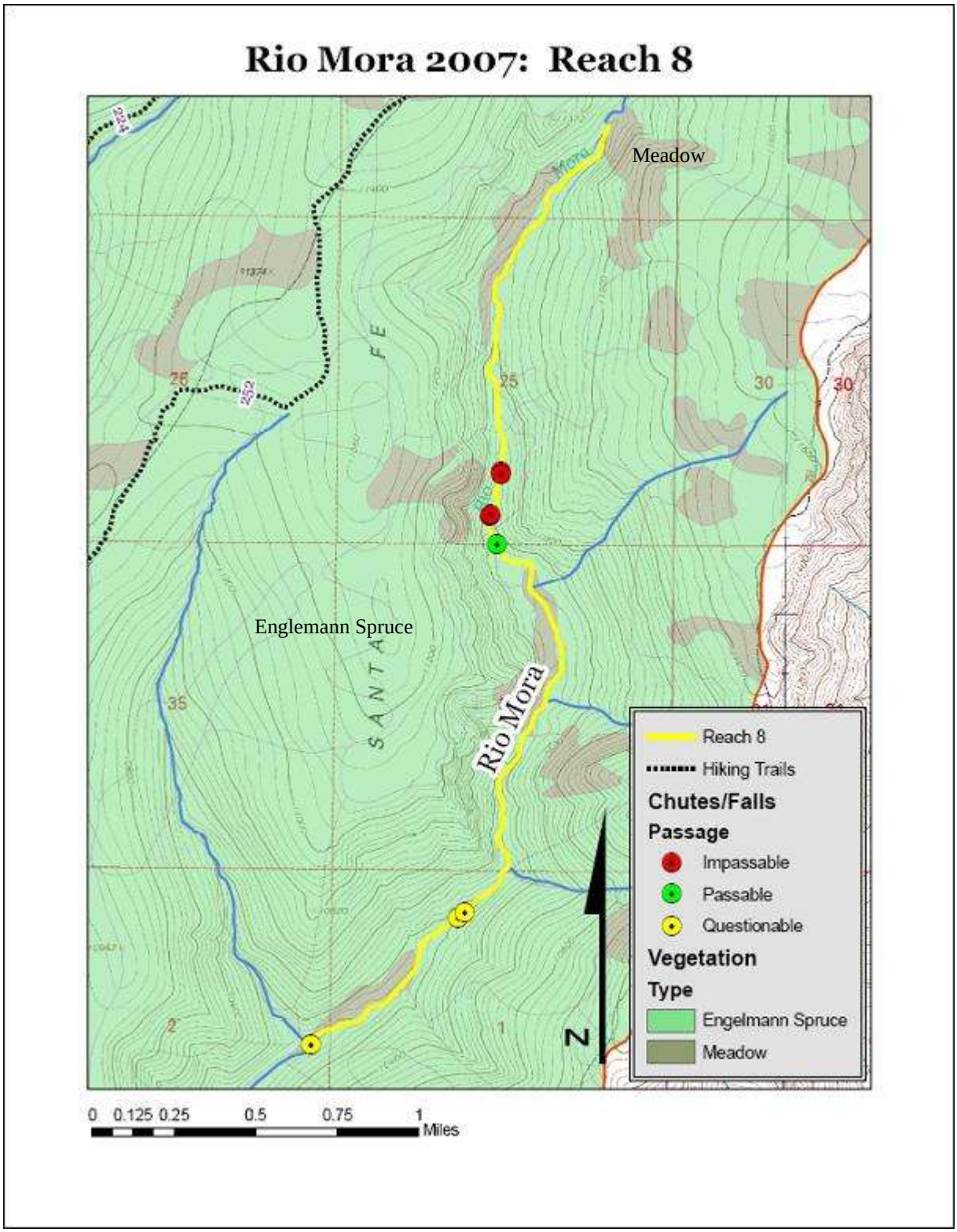
Table 283 - Habitat characteristics of Reach 7.

Reach	Pool:Riffle Ratio	Bankfull Width:Depth	Pieces of LWD per Mile	Total Unstable Banks (ft)	% Unstable Banks
7	1:1	9.0:1	41.1	35	0.2%
Properly Functioning Indicators	-	<12:1	>30	-	<10%

Recommendations

This reach is in excellent condition and marks the beginning of a new sort of stream habitat characterized by steep chutes through narrow sections of canyon and enhanced by boulders from rockslides. All aspects of this reach are properly functioning, and there are no trails in the area.

REACH 8: CONFLUENCE WITH SECOND SIGNIFICANT LB UNNAMED CONTRIBUTOR TO VALLEY CONFINEMENT BELOW HEADWATERS



Map 9 - Reach 8 Map.

Photo 30 - Rocky, high-gradient flows.

Reach 8 begins at the confluence of the Rio Mora and an unnamed mapped tributary flowing from the North, located at stream mile 14.3. The reach extends for 3.5 miles beyond the confluence to beginning of an extremely steep and considerably long boulder cascade. The reach was broken at this point due to the dramatic change caused by the mesa pinching together forming a narrow, steep notch larger in scale than anything experienced in Reach 8. In this reach the stream can be classified as Rosgen type B stream with sections of A and Aa+ type channel.

The reach begins in the same meadow that ended reach 8, with moderate stream grades, cobble runs, and a narrow stream width completely covered by arching riparian willow and alder. Within a half mile the valley walls pinch together and the broad valley floor transitions dramatically to a narrow and extremely high-gradient notch between the mesas. In this section, continuing for about 800', the stream cascades through numerous chutes and falls between a series of deep scour pools situated among boulders and dramatic bedrock features.

At the top of the notch the valley again broadens and the stream moderates significantly, and the valley floor becomes a broad and expansive willow meadow. In this section, lasting over a mile - approximately 6200' - the river returns to the more usual alteration between long, occasionally extremely long, shallow cobble runs and shorter, deeper boulder runs periodically interrupted by pools where bedrock is exposed or the river makes a quick bend at the valley's edge.

Photo 31 - Small fall on unnamed tributary.

Following the end of the meadow the mesas once again pinch together, dramatically narrowing the valley and creating another section of steep boulder cascades with deep scour pools and abundant bedrock features. This second notch, also about 800' in length, is less steep than the first similar section. Most of this section is classified as Rosgen type A, though in places the steepness is so great that the stream is actual Rosgen type Aa+.

From the top of the notch the river immerges into another broad, expansive valley, this time characterized by a dominance of grass that is typical of a true sub-Alpine meadow, with willows remaining in small shrub and prostrate form along the immediate banks of the stream. The meadow section extends for nearly a mile and a half – over 7500' – and only in the very end of the section do spruce and fir return to the stream banks replacing the grassy

meadow. As with the previous meadow section, this section is characterized by long and occasionally extremely long and shallow cobble riffles with some deeper boulder riffles and very occasional pools. The stream remains narrow, seldom averaging more than 12 feet wide. Throughout the meadow many tributaries, some of decent contribution to the Mora, entered the Mora, the effective of which noticeably decreased flow volume by the end of the meadow section.

Access to Reach 8 is limited. For the majority of the reach there is no formal trail along the stream and the nearest trails are the Bordo del Medio Trail #252 along the mesa to the west and the Skyline #251 trail along the mesa to the East. The Gascon Trail #239 crosses the highest sub-Alpine meadow of the Mora, approximately 1.5 miles above the reach break. All of these trails are a considerable distance into the wilderness and far from the nearest trailhead.

Photo 32 - Narrow meanders through thick riparian vegetation.

Vegetation throughout the reach varies from section to section. The lower two meadow sections each had abundant and thick alder and willow riparian vegetation, with sup-Alpine spruce and fir forests covering the ridges and margins of the meadows. The forests would converge to the stream banks just before and after each steep notch section, though within the actual steep sections vegetation was not abundant amid the boulders and bedrock. The final meadow witnessed a gradual thinning of alder and then willow riparian vegetation, until willow remained only in a buffer along the stream. Sup-alpine spruce and fir woods continued to forest the ridges. Within each meadow Arizona willow was observed, though at no point was it a dominant species, but was rather a significant member of number of willow species present.

Photo 33 - Thick willow vegetation.

Beaver activity was minimal throughout the reach, with some old and very old evidence being observed in the middle two meadow sections. The evidence included a small beaver pond; the pond was greatly filled with sediment and obviously disused for some time.

Stream stability in this reach was not and issue, and the Mora exhibited a near total percentage of stable banks. The only small places of instability include occasional meanders that cut into the outside bank, and several unofficial and game trails which crossed the stream.

Reach 8 was also the first reach to have Rio Grand Cutthroat trout. Cutthroats were likely first observed in the very first meadow of the reach, and the first steep notch section is likely to be the permanent barrier between the Cutthroats and the Brown trout found in lower reaches. Cutthroat were readily observed in the

pools of the first steep notch section and every other section with the exception of the final meadow section. The small size of the Mora and the clarity of the pools allowed for excellent observation of Cutthroat and no observations of Brown trout from the first steep notch section onward.

Originally this reach was surveyed to extend all of the way to the headwaters of the Mora. After the survey was completed, the gained knowledge of the uniqueness of the third steep notch section, which became Reach 9, and the fact that it contained the likely barrier to upstream migration of Cutthroat prompted splitting it from Reach 8. The last sub-Alpine meadow was also split, creating Reach 10, as it is the highest meadow of the Mora, differs greatly in hydrology, and lacks Rio Grand Cutthroat trout.

Habitat Characteristics

Reach 8 is divided into 106 NSOs, measuring 5.3 miles (28,075 feet). Forty-five (45) NSOs are pool habitats, and comprise 44.6% of the stream habitat. Forty-six (46) riffle habitats make up 45.5% of the stream habitat in Reach 8 (see Table 44).

Table 44- Summary of Reach 8 habitat types

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length* (%)	Stream Habitat** (%)	Properly Functioning Indicators
Pool	32	1141	5.8	43.8	>30%
Riffle	33	18527	94.2	45.2	-
Culvert	0	0	0.0	0.0	-
Tributary	2	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	8	570	N/A	11.0	-
Dry Channel	0	0	0.0	0.0	-
Total	75	20238	100	100	-

*Percent Stream Length calculated with only riffle, pool, culvert, and falls habitat types.
**Percent Stream Habitat calculated using all stream habitat types except tributary.

Table 295 - Summary of habitat and substrate composition in riffle habitat of Reach 8.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
8	33	561.4	10.4	1.1	2.2	
Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
8	3.9	20.0	33.3	27.6	15.2	100
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Table 306 - Summary of pool habitat and substrate percentages in Reach 8.

Pool Habitat Summary											
Reach	# Of Pools	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC	Avg. Residual Depth (ft)	# of Pools/Mile	# of Pools w/ Residual Depth ≥1'	# of Pools w/ Residual Depth ≥1'/Mile	# of Pools w/ Max. Depth ≥3'	# of Pools w/ Max. Depth ≥3'/Mile
8	32	35.7	12.8	3.2	1.0	2.1	9.1	31	8.9	14	4.0
Properly Functioning Indicators	-	-	-	-	-	≥1ft	-	-	-	-	-

Substrate Summary							
	Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
	8	17.5	18.1	22.2	16.3	25.9	100.0

Orange – Dominant Substrate

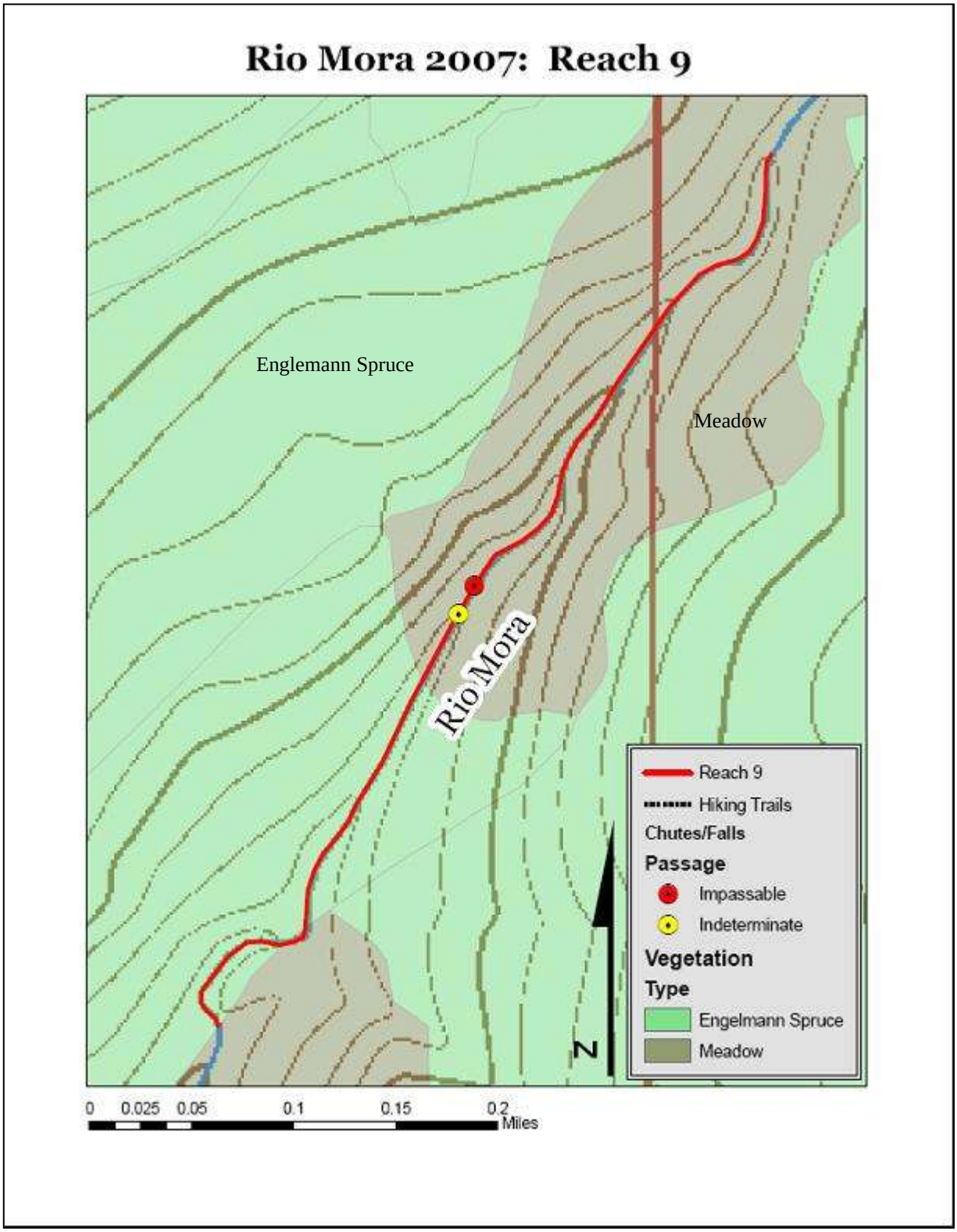
Table 317 - Habitat characteristics of Reach 8.

Reach	Pool:Riffle Ratio	Bankfull Width:Depth	Pieces of LWD per Mile	Total Unstable Banks (ft)	% Unstable Banks
8	1:1	11.8:1	38.9	245	0.6%
Properly Functioning Indicators	-	<12:1	>30	-	<10%

Recommendations

This reach is in excellent condition with stable banks and thick riparian vegetation which continues unbroken by trails.

REACH 9: VALLEY CONFINEMENT BELOW HEADWATERS TO VALLEY WIDENING BELOW HEADWATERS



Map 10 - Reach 9 Map.

Reach 9 begins at the start of an extremely steep and considerably long boulder cascade at stream mile 17.8 and continues for half a mile to the end of the same cascade, where the valley then broadens and fills with the sub-Alpine meadow of the Rio Mora's headwaters. The reach was broken due to a change in river morphology, as the highest meadow of the Mora was in stark contrast to the steep boulder notch of Reach 9. In this reach the stream can be classified as Rosgen stream type A and Aa+.

Photo 34 - Deep scour pools and boulder-features.

The reach begins following the end to the meadow at the end of Reach 8. Following the meadow the mesas pinched together, in the same pattern of Reach 8, for the third and final time, dramatically narrowing the valley and producing the steepest section of boulder and bedrock cascades on the Rio Mora. In the reach, the forested slopes were turned mostly to talus and the stream was filled with a propensity of enormous boulders and bedrock protrusions. In all, this steep section was the longest by far of all three such sections in both Reach 8 and 9, continuing for nearly 3000' feet in length compared to 800' for similar sections in Reach 8. While mostly a Rosgen type A channel, this section contained numerous stretches of incredibly steep talus cascades, waterfalls, and bedrock chutes which were well over 10% in gradient, classifying some sections as Rosgen type Aa+.

Access to Reach 8 is limited. For the majority of the reach there is no formal trail along the stream and the nearest trails are the Bordo del Medio Trail #252 along the mesa to the west and the Skyline #251 trail along the mesa to the East. The Gascon Trail #239 crosses the highest sub-Alpine meadow of the Mora, approximately 3/4 of a mile above the reach break. All of these trails are a considerable distance into the wilderness and far from the nearest trailhead.

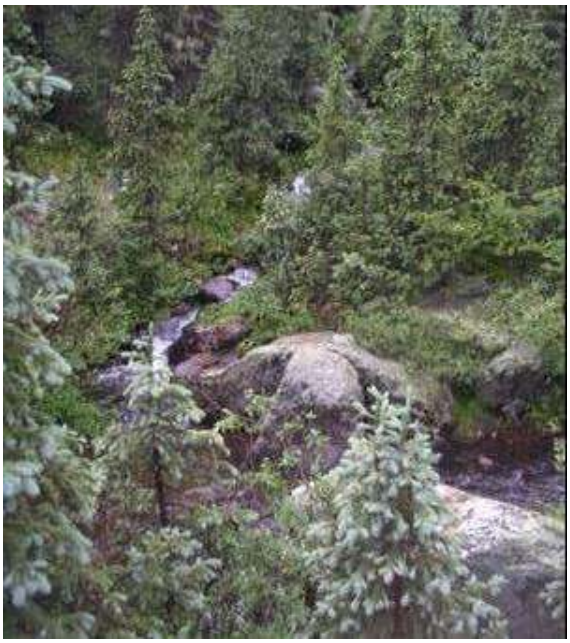


Photo 35 - High gradient riffle over boulders.

Riparian vegetation was limited throughout the reach. The forests would converge to the stream banks, replacing meadow, just before and after the steep notch, though within the actual notch vegetation was not abundant amid the boulders and bedrock. The channel itself was deeply imbedded with the forest rising high above the stream on large, tall benches.

Beaver activity was not observed in the reach, and stream stability was near complete.

Reach nine was the second and final reach to have Rio Grand Cutthroat trout. Reach 9 contained the barrier to upstream migration of Cutthroat in NSO 332; Riffle 38. The barrier, a large cascade without an adequate pool at its base, was followed by an extremely shallow – less than 2" deep – riffle that appears to act as an impassable barrier to upstream migration, even in times of high flow. Above this barrier no fish were observed for the remainder of the survey. This effectively prevents the highest mile of the Rio Mora from serving as habitat for Cutthroat.

Originally this reach was surveyed as part of a much longer Reach 9 which extended from the beginning of Reach 8 all of the way to the headwaters of the Mora. After the survey was completed, the gained knowledge of the uniqueness of this third steep notch section, which became Reach 9, and the fact that it contained the likely barrier to upstream migration of Cutthroat prompted splitting it from Reach 8. The last sub-Alpine meadow was also split, creating Reach 10, as it is the highest meadow of the Mora, differs greatly in hydrology, and lacks Rio Grand Cutthroat trout.

Habitat Characteristics

Reach 9 is divided into 17 NSOs, measuring 0.5 miles (2,910 feet). Eight (8) NSOs are pool habitats, and comprise 47.1% of the stream habitat. Seven (7) riffle habitats make up 41.2% of the stream habitat in Reach 9 (see Table 48).

Table 328 - Summary of Reach 9 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length* (%)	Stream Habitat** (%)	Properly Functioning Indicators
Pool	8	284	10.5	47.1	>30%
Riffle	7	2426	89.5	41.2	-
Culvert	0	0	0.0	0.0	-
Tributary	0	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	2	200	N/A	11.8	-
Dry Channel	0	0	0.0	0.0	-
Total	17	2910	100	100	-

*Percent Stream Length calculated with only riffle, pool, culvert, and falls habitat types.
**Percent Stream Habitat calculated using all stream habitat types except tributary.

Table 339 - Summary of habitat and substrate composition in riffle habitat of Reach 9.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
9	7	346.6	8.2	0.9	1.8	
Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
9	7.1	17.1	32.9	34.3	8.6	100.0
Properly Functioning Indicators	<20.0	-	-	-	-	-

Orange – Dominant Substrate

Table 50- Summary of pool habitat and substrate percentages in Reach 9.

Pool Habitat Summary											
Reach	# Of Pools	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC	Avg. Residual Depth (ft)	# of Pools/Mile	# of Pools w/ Residual Depth ≥1'	# of Pools w/ Residual Depth ≥1'/Mile	# of Pools w/ Max. Depth ≥3'	# of Pools w/ Max. Depth ≥3'/Mile
9	8	35.5	10.8	2.4	0.8	1.7	16.0	7	14.0	2	4.0
Properly Functioning Indicators	-	-	-	-	-	≥1ft	-	-	-	-	-

Substrate Summary								
	Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total	
	9	30.0	11.3	16.3	25.0	17.5	100.0	

Orange – Dominant Substrate

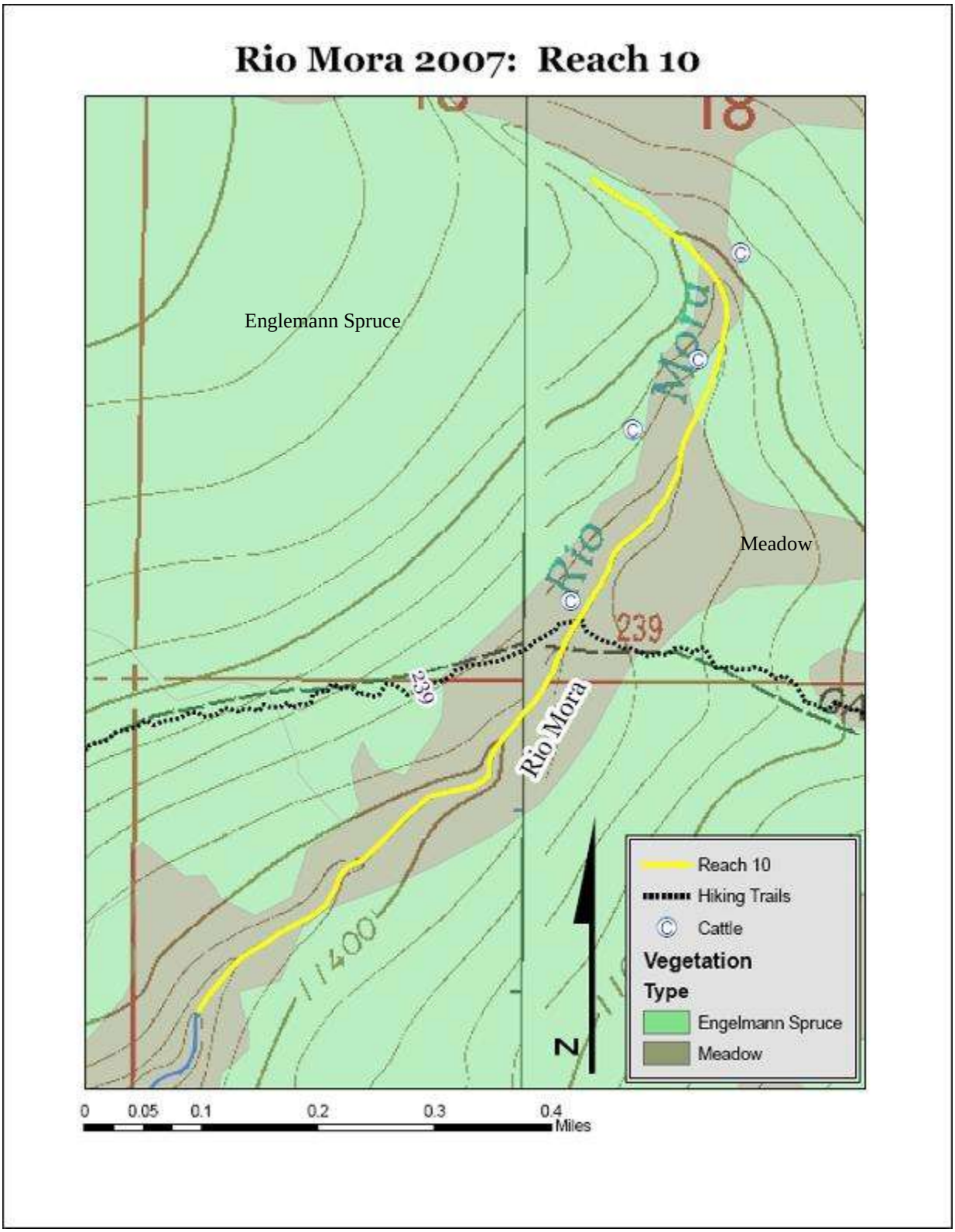
Table 341 - Habitat characteristics of Reach 8.

Reach	Pool:Riffle Ratio	Bankfull Width:Depth	Pieces of LWD per Mile	Total Unstable Banks (ft)	% Unstable Banks
9	0.9:1	N/A	38.0	5	0.1%
Properly Functioning Indicators	-	N/A	>30	-	<10%

Recommendations

This reach is in excellent condition with stable banks, thick vegetation, and no evidence of recreation or grazing.

REACH 10: VALLEY WIDENING BELOW HEADWATERS TO HEADWATERS



Map 11 - Reach 10 Map.

Reach 10 begins at the top of the steep boulder cascade that formed Reach 9, where the valley dramatically widens and is filled with the sub-Alpine meadow of the Mora's headwaters. This transition occurs at stream mile 18.3, and the reach extends for one mile to the highest reaches of the Mora's headwaters and the effective beginning of the entire river. In this reach the stream can be classified as Rosgen type E channel.

Photo 37 - Upstream view of the final reach.

Reach 10 is chiefly composed of the final sub-Alpine meadow of the stream and the highest reaches of the headwaters. This meadow section, extending for the remaining stretch of the river – about 5000' in length – was characterized by a broad and expansive grassy meadow, minimal willow vegetation along the banks, and low valley walls rising scarcely a few hundred feet higher than the valley by the river's end. For the majority of the section the Mora was a 2' wide slit in the grass, running an average of 1.8' deep and meandering slightly through the meadow. The Gascon Trail #239 crossed the Rio Mora about halfway through the section. Multitudes of tributaries, most small trickles but a few proportionally large to the tiny Mora, joined the stream throughout the meadow. Toward the end of the section two breaks in the stream each removed half of the remaining flow of the Mora. The most incised stream channels were followed and the Mora finally ended at a small but strong seep in the side of the valley headwall.

Photo 36 - Incised channel at low flows.

Reach 10 witnessed a gradual and then complete loss of willow riparian vegetation, with the final stretches of the Mora being a 2' wide slit in an expansive grass and wildflower meadow. Sup-alpine spruce and fir woods continued to forest the ridges.

Beaver activity was not observed throughout the reach.

The stream stability of Reach 10 was in the worst condition of any reach on the Mora. There the meanders of the Mora caused large slices of grassy sod to break and collapse. The banks were also predominantly undercut. Around the Gascon Trail crossing, bank degradation was at its worse, with abundant collapsed and denuded banks surrounding the obvious trail through the stream and its banks.

Photo 38 - Shallow gradient flow through high meadow.

The stream instability around the Gascon Trail Crossing was further compounded by the presence of cattle, whose hoof prints, droppings, and grazing evidence obviously attributed a large portion of the stream instability to cattle. Up beyond the trail crossing cattle-induced stream instability remained a constant and present observation. Large sections of muddy, hammered stream banks left the meadow soft and saturated and the adjoining stream banks destroyed. Cow droppings were abundant, often right on the waters edge, and the many tributaries joining the Mora displayed evidence of intense cattle pressure. About 20 cattle were witnessed on the forest's edge several hundred feet from the Mora. The damage caused by the cattle in this meadow was the worst damage anywhere on the Mora, and due to the small size of the Mora and the perfusion of tributaries in the headwaters the damage seems to be amplified and more pervasive than the same cattle pressure might induce in sections lower on the Mora.

Reach 10 is situated entirely above the barrier to upstream migration found in Reach 9. No fish were observed anywhere within the reach, confirming the likelihood that Reach 9 is then end of current Cutthroat habitat on the Mora.

According to Phil Howes, Warden with New Mexico Game and Fish, an electro-fishing survey conducted in the summer of 2006 found no Cutthroat in the highest meadow section. Likely portions of the highest stream mile of the Mora are ephemeral, going dry during times of low water in between snow melt and summer monsoons, or else in fall before winter precipitation, and also likely freeze solid during the coldest winter months. These factors, along with the barrier found in the lower steep notch section, would likely prevent the last stream mile of the Mora from ever being adequate Cutthroat habitat.

Habitat Characteristics

Reach 10 is divided into 14 NSOs, measuring 1 mile (5,072 feet). Five (5) NSOs are pool habitats, and comprise 45.5% of the stream habitat. Six (6) riffle habitats make up 54.5% of the stream habitat in Reach 10 (see Table 52).

Table 352 - Summary of Reach 10 habitat types.

Habitat Type	Number of Habitats	Total Stream Habitat (ft)	Stream Length* (%)	Stream Habitat** (%)	Properly Functioning Indicators
Pool	5	160	3.2	45.5	>30%
Riffle	6	4767	96.8	54.5	-
Culvert	0	0	0.0	0.0	-
Tributary	3	N/A	N/A	N/A	-
Falls	0	0	0.0	0.0	-
Side Channel	0	145	N/A	0.0	-
Dry Channel	0	0	0.0	0.0	-
Total	14	5072	100	100	-

*Percent Stream Length calculated with only riffle, pool, culvert, and falls habitat types.
**Percent Stream Habitat calculated using all stream habitat types except tributary.

Table 363 - Summary of habitat and substrate composition in riffle habitat of Reach 10.

Riffle Habitat Summary						
Reach	# Riffles	Avg. Length	Avg. Width	Avg. Depth	Avg. Max Depth	
10	6	794.5	1.8	0.7	1.6	
Substrate Summary						
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total
10	23.3	43.3	28.3	5.0	0.0	100
Properly Functioning Indicators	<20.0	-	-	-	-	-

Red – Not Properly Functioning
Orange – Dominant Substrate

Table 374 - Summary of pool habitat and substrate percentages in Reach 10.

Pool Habitat Summary											
Reach	# Of Pools	Avg. Length (ft)	Avg. Width (ft)	Avg. Max Depth (ft)	Avg. PTC	Avg. Residual Depth (ft)	# of Pools/Mile	# of Pools w/ Residual Depth ≥1'	# of Pools w/ Residual Depth ≥1'/Mile	# of Pools w/ Max. Depth ≥3'	# of Pools w/ Max. Depth ≥3'/Mile
10	5	32.0	3.6	2.2	0.4	1.7	5.0	5	5.0	0	0.0
Properly Functioning Indicators	-	-	-	-	-	≥1ft	-	-	-	-	-

Substrate Summary							
Reach	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	Total	
10	34.0	24.0	34.0	8.0	0.0	100.0	

Orange – Dominant Substrate

Table 385 - Habitat characteristics of Reach 10.

Reach	Pool:Riffle Ratio	Bankfull Width:Depth	Pieces of LWD per Mile	Total Unstable Banks (ft)	% Unstable Banks
10	1.2:1	N/A	0[1]	1,106	11.2%
Properly Functioning Indicators	-	N/A	>30	-	<10%

Red – Not Properly Functioning
[1] Large Woody Debris numeric is not applicable in meadow reaches.

Recommendations

This reach showed more damage from grazing than any other. Bank stability was severely impacted in areas from cattle accessing the significantly incised river, and although the % of unstable banks is not remarkable, the areas which are impacted are in extremely poor condition. This situation is difficult to remedy as long as grazing continues to be present because of the incised channel and wet, grassy banks which are highly prone to damage and whose deterioration creates easy access points for cattle looking for water. Severe limitations of grazing, or the construction of exclosure fencing, could lead to improved riparian conditions.

Photo 39 – Chrysanthemums growing on a spring at the top of the Rio Mora.

APPENDIX A: **Supporting Information**

Table 396 - Summary of measurements and estimations used in the Region 3 Hankins/Reeves stream survey protocol (Stream Inventory Handbook April 2002).

Measurements	Estimations
Maximum depth of pools, riffles, and side channels	Average depth of riffles
Depth of pool tail crest	Substrate percentages in bankfull width
One bankfull width depth transect per reach	Average wetted width of riffles and pools*
Number of large woody debris within bankfull	Length of bank instability
Surveyor collected main channel and tributary water temperature and time	Total length, wetted width, and maximum depth of side channels
Thermograph collected water temperature (Recorded every four hours)	Length of first habitat unit of tributaries and percent stream flow contribution

*Width estimations were corrected by the comparison of a minimum of 10% measured habitats in each reach to the related estimates. This technique was used to produce correction factor for each reach, which was then applied to analysis of the widths of that reach and the entire stream analysis.

Table 407 - Feature types collected by Trimble Geo Explorer 3 GPS units.

Reach Breaks	Tributary Mouth
Woody Debris Jams (of 3 or More Pieces)	Barriers to Fish Passage
Areas of Concern (Major Erosion, Road Crossings, Etc…)	Side Channels (only longer than 10 times the wetted width of the main channel)
Beaver Dams (If Active and over 1' in Height)	Thermograph Stations
Snorkel Survey Transect Locations	Culverts
Flow Stations	Water Temperature Monitoring Stations

APPENDIX B: Glossary

Eutrophication: Having waters rich in mineral and organic nutrients that promote a proliferation of plant life, especially algae, which reduces dissolved oxygen content and often causes the extinction of other organisms.

Gabion Structures: Wire boxes filled with cobble or larger sized substrate to create "walls" and used for bank stability. Much like riprap, these structures have equally adverse effects as streams adjust to this hardening.

Hybridization: The result of a genetic cross between different species. In the fish populations of New Mexico, Rio Grande cutthroat trout when in contact with rainbow trout will cross breed to produce cut-bows. Hybridization destroys the genetic purity of Rio Grande cutthroat trout populations.

HUC Code: Hydrologic Unit Code used to identify watersheds.

Large Woody Debris (LWD): Wood that is within the bankfull channel for a habitat unit and is above the minimum size requirement. Woody debris is classified into categories with relation to length and diameter. The smallest wood classified in this survey must be greater than 6 inches in diameter at a length of 20 feet from the largest end. For analysis only wood with a diameter of greater than 12 inches at a length of 35 feet from the large end are used (designated as medium and large pieces).

Large Woody Debris Jams: A minimum of 3 pieces of LWD interacting within the bankfull channel.

Meadow Reach: Predominance of valley formation has meadow characteristics, which includes lacking trees in the active floodplain. No LWD recruitment within the reach.

Natural Sequence Order (NSO): A division system used to classify stream habitats. Each habitat is assigned a unique NSO number in consecutive order from the mouth upstream.

Response Reach: Low-gradient and/or constricted reaches typically located downstream from high gradient transportation reaches. Response reaches are noted for their channel and habitat formation caused by upstream factors.

Riparian Vegetation: Stream bank or streamside vegetation; influenced by wet conditions associated to a high water table or live water.

Riprap: A loose assemblage of broken stones erected in water or on soft ground as a foundation. Riprap is used to improve bank stability in streams, but has other and occasionally adverse effects.

Seep: A tributary with very slow flow, often associated with draining wet meadows

Spring: A flowing tributary with a source within 100 feet from the stream channel.

Stream: All tributaries that are not classified as a seep or spring. Usually streams are associated with a distinct drainage and have a more significant flow than the other tributary types.

Stream Habitat (%): A calculation of relative habitat types, which includes culverts, falls, pools, riffles and secondary channels. Tributary habitats are not included in the calculation.

Stream Length (%): A calculation of relative main channel habitat types, which includes culverts, falls, pools, and riffles. Tributary and secondary channel habitats are not included in the calculation.

Transport Reach: High gradient and non-constricted reaches that act as a conveyor belt of source materials, such as large wood, substrate and fine materials.

LITERATURE CITED

Allen, A. W. 1983. Habitat suitability index models: beaver. U.S. Fish and Wildlife Service, F. Collins, Colorado.

Apodaca, Anne. 2005. Española Recreation Staff. Santa Fe National Forest. Personal Communication. Española, NM.

Apodaca, Anne, and Miles Standish. 2004. Española Recreation Staff and Recreation Technician, Santa Fe National Forest. Personal Communication. Española, NM.

Baldwin, Anne. 2005. Supervisory Archeologist, Española/Coyote Resource Area, Santa Fe National Forest. Personal Communication. Española, NM.

Baldwin, Anne. 2004. Supervisory Archeologist, Española/Coyote Resource Area, Santa Fe National Forest. Personal Communication. Española, NM.

Brodie, J. 1996. Bureau of Land Management. Environmental Education Homepage. http://www.blm.gov/education/riparian/define.html.

Calamusso, B., and J. N. Rinne. 2004. Distribution and abundance of Rio Grande Cutthroat trout (*Oncorhynchus clarki virginalis*), relative to an introduced salmonid, in Northern New Mexico. Pgs 31-37 in G.J. Scrimgeour, G. Eisler, B. McCulloch, U. Silins and M. Monita. Eds. Forest Land—Fish Conference II – Ecosystem Stewardship through Collaboration. Proc. Forest-Land-Fish Conf. II, April 26-28, 2004, Edmonton, Alberta.

Calamusso, B., J. N. Rinne, and P. R. Turner. 2002. Distribution and abundance of the Rio Grande sucker in the Carson and Santa Fe National Forests, New Mexico. The Southwestern Naturalist 47 (2):182-186.

Clements, C. 1991. Beavers and riparian ecosystems. Rangelands 13:277.

Cordell, Linda S. 1979. Cultural Resources Division: Middle Rio Grande Valley, New Mexico. U. S. Government Printing Office, Washington, D.C.

Dean, Alison. 2002. Final Canjilon—Rio Chama HCA. 5th Code Watershed. HUC # 1302010206. Santa Fe National Forest. Santa Fe, NM.

deByle, N. V. 1985. Wildlife. In: DeByle, N. V. and R. P. Winokur, eds., Aspen: Ecology and Management In the Western United States. Rocky Mt. For. And Range Exp. Sta., USDA Forest Service, Ft. Collins, Colorado.

Dixon, John. 2005. Zone Soil Scientist/Hydrologist, Coyote and Española Ranger Districts, Santa Fe National Forest. Personal Communication. Coyote, NM.

Dunham, J. 1999. Stream temperature criteria for Oregon's Lahontan cutthroat trout *Oncorhynchus clarki henshawi*. Department of Biology and Biological Resources Research Center University of Nevada.

Fausch, K. D., and T. G. Northcote. 1992. Large woody debris and salmonid habitat in a small coastal British Columbia stream. Canadian Journal of Fisheries and Aquatic Sciences 49: 682-693.

Fenneman, Nevi M. 1931. Physiography of Western United States. Maple Press. New York.

Ferrell, Sean. 2005. Forest Fisheries Biologist, Santa Fe National Forest. Personal Communication. Jemez Springs, NM.

Furniss, M. J., T. D. Foelofs and C. S. Yee. 1991. Road construction and maintenance. In: Meehan W. R. (ed.). Influences of Forest and Rangeland Management on salmonid fishes and their habitats. Special Publication 19. Bethesda, MD: American Fisheries Society: 297-323.

Gard, R. 1961. Effects of beaver on trout in Sagenhen Creek, California. J. Wildl. Manage. 25:221.

Grayson, R .B., S. B. Haydon, M. D. A. Jayasuriya, and B. L. Finlayson. 1993. Water quality in mountain ash forests; separating the impacts of roads from those of logging operations. *Journal of Hydrology* 150: 459-480.

Hill, David V. 1990. The Pinabetal/Pinabetosa Cultural Resource Survey in Jarosa Drainage. Ms on file, USDA Forest Service, Southwest Region, Albuquerque, New Mexico (SFNF Report No. 1988-10-108B).

Howes, Phil. 2007. Game and Fish Officer, New Mexico Department of Game and Fish. Pecos, NM.

Irwin-Williams, Cynthia. 1979. Post-Pleistocene Archaeology, 7000-2000 B.C. In Handbook of North American Indians, Volume 9, Southwest. Edited by A. Ortiz, Smithsonian Institution, Washington, D.C.

Julyan, Robert H. 1995. The Place Names of New Mexico. The University of New Mexico Press, Albuquerque.

Knowlton, Clark S. 1970. Violence in New Mexico: A Sociological Perspective. California Law Review. vol. 58, no. 4.

Lujan, Michael. Natural Resources Staff Officer. Personal communication. January, 2008.

Maes, R. 2005. Aquatic TES Biologist. Wildlife, Fish, and Rare Plants. USDA Forest Service Region 3, Regional Office. Personal Communication. Albuquerque, NM.

NMED. 2004a. Draft Record of Decision (ROD) for the 2004-2006 State of New Mexico §303(d)/§305(b) Integrated List for Assessed Surface Waters. New Mexico Environment

Department. Surface Water Quality Bureau. Santa Fe, NM. http://www.nmenv.state.nm.us/wqcc/303d-305b/2004/FinalDraft/DRAFT2004-2006_303dROC.pdf.

NMED. 2004b. SFNF Chama data request. Data from NMED water quality monitoring sites. Prepared by Gary Schiffmiller. New Mexico Environment Department, Surface Water Quality Bureau. Santa Fe, NM.

NMED. 2004c. Total Maximum Daily Loads (TMDLs) for the Lower Rio Chama Watershed (Below El Vado Reservoir to the Confluence with the Rio Grande). New Mexico Environment Department, Surface Water Quality Bureau. http://www.nmenv.state.nm.us/swqb/Chama/Edited_Lower_Chama_final05-26-04.pdf.

NMDGF. 2002. Long Range Plan for the Management of Rio Grande Cutthroat Trout in New Mexico. New Mexico Department of Game and Fish. Fisheries Management Division. Santa Fe, NM.

NMDGF. 2005. New Mexico Game and Furbearer Rules and Information: 2005-2006 License Year. Santa Fe, NM.

Olson, R. and Wayne, H. 1994. Beaver: Water resources and riparian habitat manager. University of Wyoming, Laramie, WY.

Orr, Mary. 2005. Zone Wildlife Biologist for Coyote and Española Districts, Santa Fe National Forest. Personal Communication. Española, NM.

Orr, Mary. 2004. Zone Wildlife Biologist for Coyote and Española Districts/Acting Forest Biologist, Santa Fe National Forest. Personal Communication. Española, NM.

Parker, M., F. J. Wood, B. H. Smith, and R. G. Elder. 1985. Erosional down cutting in lower order riparian ecosystems: Have historical changes been caused by the removal of beaver? Pgs. 35-38, In: Riparian Ecosystems and Their Management: Reconciling Conflicting uses. North American Riparian Conference, Gen. Tech. Rep., USDA Forest Service, April 16-18, University of Arizona, Tucson.

Patten, Kirk. 2005. Coldwater Fisheries Biologist. New Mexico Department of Game and Fish. Personal Communication. Santa Fe, NM.

Peterson, John F. 2005. Personal Communication with Jemez District Ranger, 23-Nov-2005.

Pritchard, V.L., and D.E. Cowley. 2005. Investigation of population genetic structure and levels of integression in Rio Grande cutthroat trout (Oncorhynchus clarki virginialis) using microsatellite markers. Final Report to New Mexico Department of Game and Fish. Santa Fe, NM.

Propst, D. L., and M. A. McInnis. 1975. An analysis of streams containing native Rio Grande cutthroat trout, *Salmo clarki virginalis*, on the Santa Fe National Forest. Santa Fe, NM, and Boulder, CO.

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, CO.

Rosgen, D., and L. Silvey. 1998. Field guide for stream classification. Wildland Hydrology. Pagosa Springs, CO.

Scurlock, Dan. 1981. Ethnohistoric Investigations. In High Altitude Adaptations along Redondo Creek: The Baca Geothermal Project, edited by C. Baker and J. Winter, pp 129 - 160. Office of Contract Archaeology, University of New Mexico, Albuquerque.

Serrano, Donald. 2004. Española Range Staff (Santa Fe National Forest)/Acting Canjilon District Ranger (Carson National Forest). Personal Communication. Española, NM.

Smith, C. E., W. P. Dwyer, and R.G. Piper. 1983. Effect of water temperature on egg quality of cutthroat trout. Progressive Fish Culturist 45:176-178.

Stuart, David E., and Rory P. Gauthier. 1981. Prehistoric New Mexico: Background for Survey. New Mexico State Historic Preservation Division, Santa Fe.

USDA Forest Service. 2001. Stream Inventory Handbook Level I & II. Portland, OR. (www.fs.fed.us/r6/water/fhr/sida/handbook).

USDA Forest Service. 2005. Santa Fe National Forest Stream Temperature Monitoring Report, 2001-2003 (author S. Eddy). Santa Fe, NM.

USDA Forest Service. 2004. Santa Fe National Forest Fisheries Program Annual Report. Santa Fe, NM.

USDA Forest Service. 2002. Upper Pecos Stream Inventory Report. Santa Fe, NM.

USDA Forest Service. 2005. Polvadera Creek Stream Inventory Report. Santa Fe, NM.

USDA Forest Service. 2002a. Rio Grande Cutthroat Trout Candidate Status Review Response Paper. Prepared by Sean Ferrell, Forest Fish Biologist. Santa Fe National Forest. Santa Fe, NM.

USDA Forest Service. 2002b. Stream Inventory Handbook Level I and II. Region 3 Version 2.0.

USDA Forest Service. 2000. Forest roads: A synthesis of scientific information. Hermann Gucinski, et al. (Ed.): 33.

USDA Forest Service. 1996. A study of Pre-Columbian and historic uses of the Santa Fe National Forest: competition and alliance in the Northern Middle Rio Grande. Volume 1: the archaeological and historical cultural resources.: 258.

USDA Forest Service. 1986. Santa Fe National Forest Plan.

USDA Forest Service. 1969. Report on the Claim of a Portion of the Polvadera Grant by Fidencia Vialpondo. Report to Forest Supervisor. 5450 Claims and Reconveyances.

Polvadera Grant – Cañones Tract No. 5. Coyote Ranger District, Santa Fe National Forest. Coyote, NM.

USDA Forest Service, Santa Fe National Forest Fisheries Files. Santa Fe National Forest. Jemez Springs, NM.

USDA Natural Resources Conservation Service, National Water and Climate Center. 2005. Site Information and Reports for Bateman. Historical Accumulated Precipitation (Daily) for Site 316 in the state of New Mexico and Snow Water Equivalent Daily Graphs. 28 March 2005. http://www.wcc.nrcs.usda.gov/snotel/snotel.pl?sitenum=316&state=nm.

USDI Fish and Wildlife Service. 2002. Candidate Status Review for Rio Grande Cutthroat Trout. Federal Register, 50 CFR Part 17. Vol. 67, No. 112: 39936-39947. June 11, 2002.

ACKNOWLEDGEMENTS

The Santa Fe National Forest Fisheries Program would like to deeply thank the following people and organizations for their support and assistance: The Pecos Ranger District for welcoming, housing, and supporting the crew in their research, Chuck Dentino for his guidance in the field and in the office, the Wildlife Fish and Rare Plants staff at the Regional office for assistance with biological and technical information, and Amy Unthank in particular for the opportunity to work on this report and for her assistance in pulling it together.